A COMPARISON OF OBJECT-ORIENTED AND PIXEL-BASED CLASSIFICATION APPROACHS USING QUICKBIRD IMAGERY

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ABSTRACT:

Many studies have been carried out to find an appropriate method to classify the remote sensing data.Traditional classification approaches are all pixel-based, and do not utilize the spatial information within an object which is an important source of information to image classification. Instead of pixels, pixel groups and object oriented techniques offer the suitable analysed to classify satellite data. To compare the object-oriented with pixel-based classification approach, a study in a small area using QuickBird data has been accomplished in this paper. In the object-oriented approach, images were segmented to homogenous area by suitable parameters in some level.Classification based on segments was done by a nearest neighbor classifier. In the pixel-based classification, the maxium likelihood classifier was used to classify the images. The result of classification and accuracy assessment show that the object-oriented approach gave more accurate and satisfying results.

1. INTRODUCTION

Traditional supervised classification and unsupervised classification are all based on the grey value of pixel itself, that is to say, only the spectral information is used for classification. The pixel-based classification approach is limited at present especially for high resolution data e.g. Quickbird images, they produce unacceptable classification results in extracting the interest objects. To solve this problem an object-oriented classification method utilizing image segmentation and fuzzy classification on the results of segmentation is suggested.

In object-oriented approach, the processing units are no longer single pixels but image objects. Firstly, the complete image has to be segmented into meaning pixel groups ,namely segments. Secondly, A set of knowledge-based classification rules to describe each class should be define. The rules includes spectral, spatial, contextual, and textual information. And then, classifier will be choosen to assign each segment to the proper class according to the rules(Leukert,2004). Compared to conventional pixel-based classification approaches,utilizing only the spectral response, image objects contain additional information, like object texture,shape, relations to adjacent regions.Arbitrary data like existing GIS layer or digital surface models(DSM) can easily be integrated and used to classification process. Object-oriented classification is suitable even for very high resolution or radar imagery.

In this study, we analyse pixel-based and object-oriented procedures and then implement this two methods using Quickbird data on a small area of Shanghai in China. The object-oriented classification is realized by EARDAS software, the pixel-based classification is implemented by eCognition software, finally we make an accuracy assessment and compare this two approaches.

2. OBJECT-ORIENTED VERSUS PIXEL-BASED CLASSIFICATION

2.1 Object-oriented Method

In general, the object-oriented classification process can be divided into the two main workflow steps: multiresolution segmentation and knowledge-based classification of the segments.

Object-oriented classification starts by segmenting the image into meaning objects. The segmentation algorighm is a bottom-up region-merging technique. It begins by considering each pixel as a separate object. Subsequently, adjacent pairs of image objects are merged to form bigger segments. The merging decision is based on local homogeneity criterion, describing the similarity between adjecent image objects. The pair of image objects with the smallest increase in the defined criterion is merged. The process terminates when the smallest increase of homogeneity exceeds a user-defined threshold. Therefore a higher threshold will allow more merging and consequently bigger objects, and vice versa. The homogeneity criterion is a combination of colour(spectral values) and shape properties(a combination of smoothness and compactness). The result of segments act as image objects which can be classifyied in next step.

The next step is classification after image segmentation. Usually classifying means assigning objects to a certain class according to the class's description. In Object-oriented classification approach the classification description is knowledge-based classificaion rules that include not only spectral properties but also shape and size characteristics, context, and texture information. The Frame of eCognition's knowledge base for the analysis and classification of image objects is the so-called class hierarchy. Within this class hierarchy it is possible to inherit image object properties from a super-class to a sub-class and also to group classes semantically. The objects then become assigned(classified) according to whether they have or have not met these properties(classifion rules). The classification is conducted by fuzzy logic .

2.2 Pixel-based classification

In the past decades, the pixel-based procedures are the main image processing means. Traditional supervised classification and unsupervised classification are all based on the single pixe, that is to say, the overall objective of classical image classification procedures is to automatically categorized all pixels in an image into land cover classes or themes. Normally, multispectral data are used to perform the classification, and only the spectral information for each pixel is utilized as the basis of categorization. Table 1 shows the attributes used for classification in the object-oriented versus the pixel-based

approaches. Because of the complexity of surface features and the limitation of spectral information, the results of traditional classification methods are often pepper-and-salt , even confusion classification.

Table1: attributes used for classification

	Color/spectral	Form/Shape	Area/Size	Texture	Context
Pixel-based	√	×	×	×	×
Object-oriented	√	√	√	√	√

3. STUDY AREA AND PRE-PROCESSING OF DATA

The study site is the PuDong New district of ShangHai in China. The test data include QuickBird panchromatic and multispectral data(see Figure1).

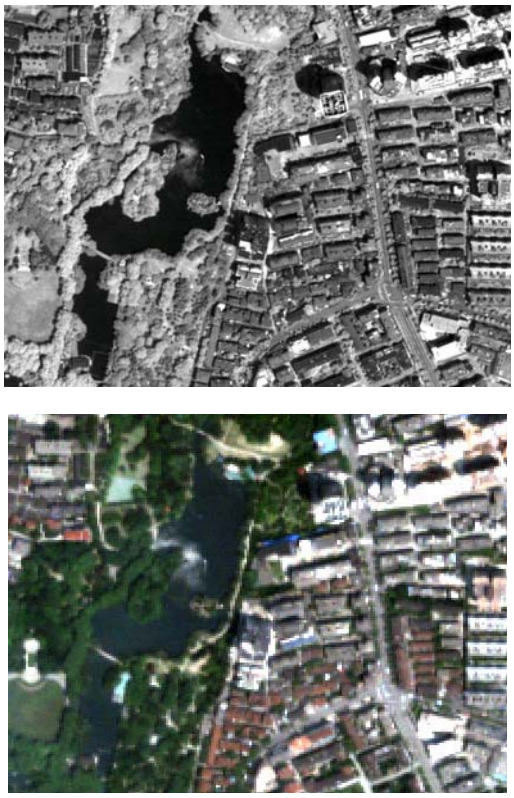

Fig.1.Quickbird panchromatic (up) and multispectral (down)

First of all, the panchromatic image was geo-referenced and then the other images were geo-referenced by using “image to image” technique. In order to benefit from high spatial resolution simultaneously with spectral information, Principal component transformation was applied to resolution merge (Marangoz, 2004). The first principal component of the four spectral Quickbird channels with 2.4 meter resolution was substituted by the 0.7 meter resolution Quickbird panchromatic channels. The results of combination then was re-transformed applying an inverse principal component transformation (see Figure2).

Fig.2. principal component transformation image

4. CLASSIFICATION AND ACCURACY ASSESSMENT

4.1 Object-oriented classification

Image segmentations of meaning objects were implemented with merged image. By test, the scale parameter was defined as 50. The result of the segmentation was shown in Figure3.

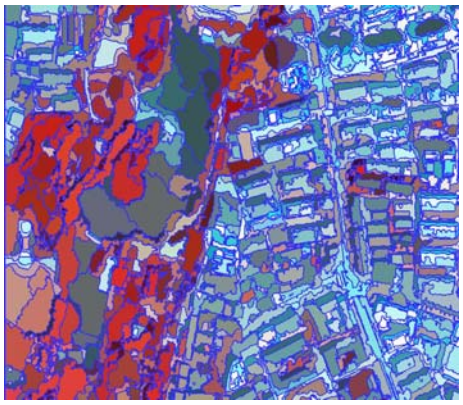

Fig. 3. Image segmentation

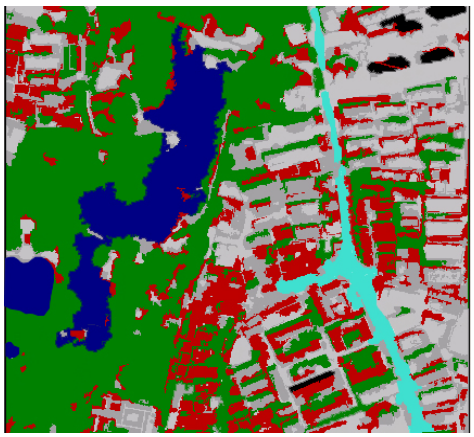

Fig. 4. results of object-oriented classification

Before the classification, the classes were assigned and the classification rules to description each class were selected . According to the ground truth, four classes were distinguished in this test: vegetation, water, building, road, and another class shadow. The nearest neighbor classifier was used. The classification were completed in iterative steps. The last classification results were shown in Figure4.

4.2 pixel-based classification

Supervised classification algorithms are applied in pixel-based classification.Minimum-distance, parallelepiped and maximum likelihood are the main classifiers for supervised classification. In this study, maximum likelihood classifier are implemented. For being compared with object-oriented techniques, the same classes with the same color information are designed in both classification approches. The results carried by Eardas software are given in Figure5.

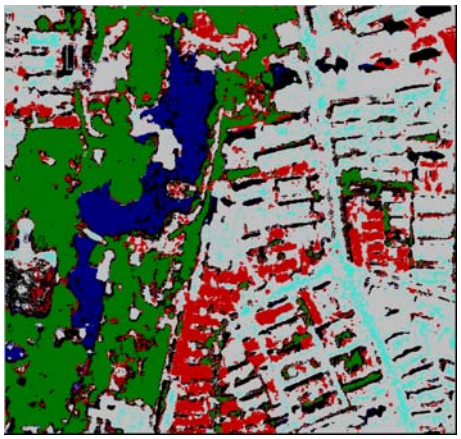

Fig. 5. results of pixel-based classification

4.3 Accuracy assessment

The results of the pixel-based and the object-oriented classification of Quickbird images are compared by accuracy assessment. The 65 samples(pixels) have been selected randomly. The reference samples are ground truth data. Then error matrices have been generated and the assessment indices are given in table 2, including the producer's accuracy, the maker's accuracy, and the kappa statistics.

From table2 we can see the object-oriented classification produced more accurate results, the overall accuracy are 20% more than the pixel-based classification. Moreover, the pixel-based classification due to utilize only spectral information of pixels in image data ,the results looks like pepper-and-salt pictures.

Tab.2. accuracy assessment results from object-oriented and pixel-based classification

Class name	Pixel-based classification			Object-oriented classification		
	Producer's accuracy %	user's accuracy %	Kappa	Producer's accuracy %	user's accuracy %	Kappa
vegetation	46.88	100.00	1.0000	68.18	100.00	1.0000
water	88.89	80.00	0.7679	90.91	100.00	1.0000
Building(gray)	60.00	60.00	0.5273	80.00	80.00	0.7636
Building(red)	100.00	53.00	0.4678	100.00	66.67	0.6061
road	33.33	20.00	0.1613	75.00	60.00	0.5738
shadow	100.00	30.00	0.2661	100.00	80.00	0.7719
	Overall accuracy: 63.08			Overall accuracy: 83.08		
	Overall kappa: 0.5398			Overall kappa: 0.7918		

5. SUMMARY

In this paper, we compared object-oriented with pixel-based classification approach using Quickbird images in a small area of shanghai city. The result shows that object-oriented classification can produce a satisfying results.The overall accuracy has been improved from 63% by pixel-based classification to 83%. The reason is that the meaning image objects(segments) not a single pixel can offer important semantic information which is necessary to interpret an image. Object-oriented image analysis techniques are a perfect classification approach especially for high resolution imagery.

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