Object-oriented Information Extraction and Application in High-resolution Remote Sensing Image

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***Abstract* — High-resolution satellite images offer abundance information of the earth surface for remote sensing applications. The information includes geometry、texture and attribute characteristic. The pixel-based image classification can't satisfy high-resolution satellite image's classification precision and produce large data redundancy. Object-oriented information extraction not only depends on spectrum character, but also uses geometry and structure information. It can provide an accessible and truly revolutionary approach. Using Beijing Quickbird high-resolution image and object-oriented classification with the eCognition software, we accomplish the cultures' precise classification. The test areas have five culture types including water, vegetation, road, building and bare lands. We use nearest neighbor classification and appraise the overall classification accuracy. The average of five species reaches 0.90. All of maximum is 1. The standard deviation is less than 0.11.The overall accuracy can reach 95.47%. This method offers a new technology for high-resolution satellite images' available applications in remote sensing culture classification.**

***Key Words*—object-oriented information extraction; high-resolution satellite image; Quickbird; eCognition software**

I. INTRODUCTION

High-resolution images have been applied in many commerce and civil fields in recent years. The spatial resolution of high-resolution images is within 10 meters [1]. These images offer abundance information of the earth surface. The information includes not only geometry and texture meanings, but attribute characteristics [2]. There are more interpretation signatures in high resolution images including color,grains,figure and so on. So the image can be better represented including the size,the shape and the relationship between neighbour objects. The grain characters are more abundant for differenr things. The detail information within composing elements of the same type of things can be token expressly [3].

However, in the traditional pixel-based classification methods only the pixels spectral information is used to extract surface features. This approach can not satisfy high-resolution images' classification precision and produce large data redundancy. It is necessary to find new classification approach to overcome this question.

Object-oriented information extraction depends on spectrum character and geometry and structure information [4]. It can provide an accessible and truly revolutionary approach. This approach interprets an image that is represented not only by single pixels, but also in meaningful image objects and their mutual relationships. The same attributes among pixels include color, shape, size and grain. Then it creates objects with same attributes. It provides a whole bundle of innovative features and techniques for automated image analysis [3][4].So we classify the image not through single pixels, but rather through extracted objects.

The software eCongnition offers a whole set of tools to practice this idea. This paper will discuss this approach and use it to extract information from Beijing Quickbird high-resolution image.

II. DATA DESCRIPTION AND EXTRACTION PROCESSION

The available Quickbird image was acquired in August of 2002 .The spatial resolution is high up to 2.4m. In this paper we select Beijing east-north 1024*1024 sub-zone [Figure 1]. And we use eCongnition software with object-oriented information extraction method to classify cultures accurately.

Figure 1. The Quickbird image to classify

The flow chart is as follows[Figure 2].

The multi-scale segmentation is the base of object-oriented classification. We can segment the image to produce polygon objects with any scale by adjusting the scale and shape parameters. These objects have the similar attribute information. The image segmentation parameters' setting is based on the basic rules and can debug again and again. Finally in this test, each layer weight is 1,the spectral and shape heterogeneity weights are both set to 0.5.The smoothness and compactness are set to 0.4,0.6. The scale parameter is 40.The results of segmentation achieve good effects[Figure 3]. After segmentation, the image objects of interest and the culture polygon are produced[Figure 4]. Here, we can see that the layer objects' characters include not only pixels values, but also grain, size and shape information.

This area mainly includes water, vegetation, road, building and bare lands. The layer object hierarchy is based on these five cultures. And it provides the base for classification. Each culture is put difference color. Assign samples to determine which class an object belongs to. Select samples from one (at least one) to several for each culture and create the training areas [Figure 5]. At this moment, we have set up the classification repository.

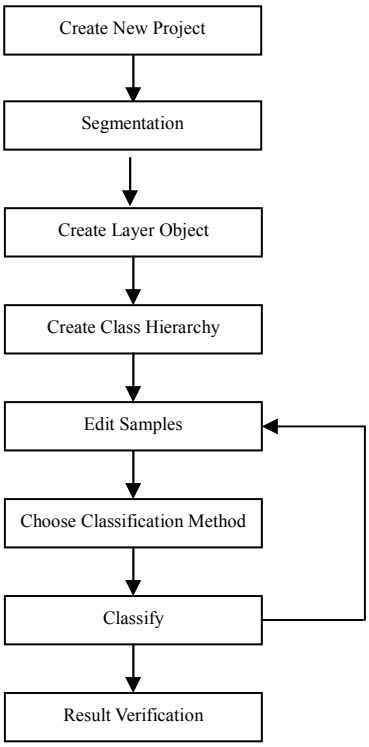

Figure 2. The classification flow chart

Figure 3. The segmentation image

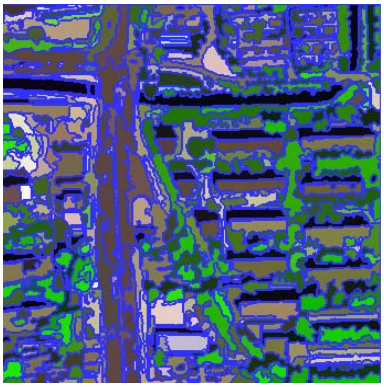

Figure 4. The map of culture polygons

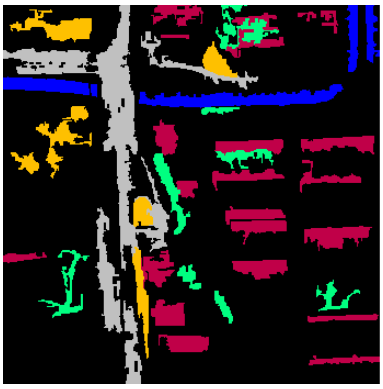

Figure 5. The display of Samples

Then let us choose classification method. Nearest neighbor classifier is an automatic generation based on sample objects. It is a supervised classification method with fuzzy rules. It classifies image objects with a given feature space and given samples for the concern classes[Figure 6] [4].Its principle is:

after sample objects have been selected for each class, the algorithm searches for the closest sample object in the feature space for each image object. If an image object is the closest sample object belongs to class A, the object will be assigned to class A.

The formula is

$$d = \sqrt{\sum_f \left[\frac{v_f^{(s)} - v_f^{(o)}}{\sigma_f} \right]^2}$$

d:distance between sample object s and image object o;

$v_f^{(s)}$:feature value of sample object for feature f;

$v_f^{(o)}$:feature value of image object for feature f;

σ_f :standard deviation of the feature values for feature f.

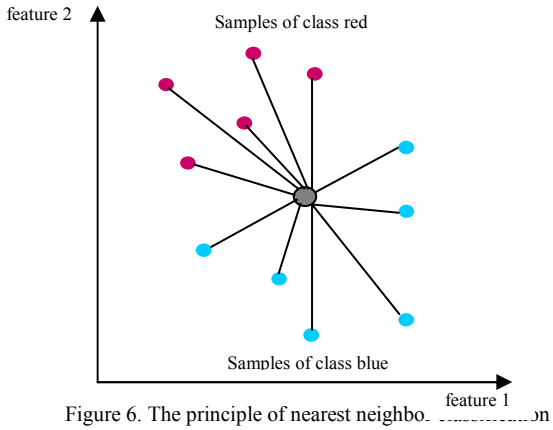

Figure 6. The principle of nearest neighbo[illegible]n

Finally, classify the image objects and display the class results. Perhaps the classification effect is not satisfied. We can reedit the samples and classify again and again until receive the best classifier effect [Figure 7].

Figure7. The final classification results by eCognition

III. VERIFICATION OF RESULTS

The eCognition software provides membership function of every class. The mean of each class reaches 0.90. All of maximum is one. The standard deviation is less than 0.11.The overall accuracy reaches 95.47%.(Table 1).

TABLE I. CLASSIFICATION RESULT ASSESSMENT

Class	Object	Mean	StdDev	Min	Max
water	7	0.9942	0.009916	0.9727	1
vegetation	171	0.9257	0.089373	0.3388	1
road	43	0.9379	0.1182	0.2894	1
building	166	0.96	0.075783	0.4068	1
bare	51	0.956	0.045535	0.8133	1
Overall Accuracy 0.95476					

Comparing with the object-oriented, we use spectral maximum likelihood (MLC) classification to classify the test area and assess its classification results (Figure 8,).

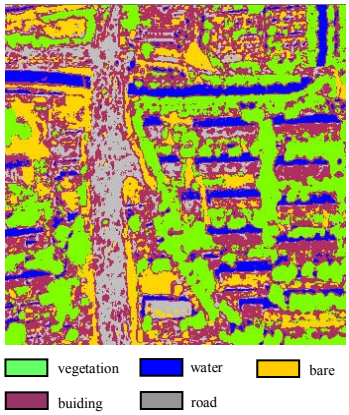

Figure 8. The result of Classification by maximum likelihood

Obviously, the traditional classification with ML has some limitations: first, the noise is big and the cultures' boundary is fuzzy; second, some building-shadow is ranged to water; third, it is difficult to correct the classification signatures. Therefore, its accuracy is lower than the object-oriented method (Table 2).

TABLE II. CLASSIFICATION RESULT ASSESSMENT BY MAXIMUM LIKELIHOOD

Class	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
water	7	24	6	0.8571	0.2500
vegetation	81	62	59	0.7284	0.9516
road	22	23	15	0.6818	0.6522
building	94	106	59	0.6277	0.5566
bare	51	41	26	0.5098	0.6341
Totals	256	256	165		
Overall Classification Accuracy 0.6445					

IV. DISCUSSION AND CONCLUSION

A. The object-oriented information extraction with eCognition provides a new tool for automated image analysis. We can use more knowledge and context information to classify cultures.

B. The multi-scale segmentation is an important base for classifying. The choice of parameter depends on the feature type to extract. Different features need different segmentation scale parameter.

C. In this paper, we only do accuracy assessment for the classification information synthetically and compare it with the traditional approach. It need do sample assessment by collecting field confirmed data. This is also one of investigation aspects of HR images data processing.

D. There are still some questions in object-oriented information extraction. We should study how to confirm the relationship of image and segmentation scales, how to build the structure groups for classification, how to combine the extracted information with GIS.

In conclusion, the object-oriented information extraction approach is a big step forward in interpretations of remote sensing images[5].We should use high resolution images adequately in many fields, such as city planning, land using change detection, environment analyzing and so on. HR images can provide more and more information to them with the new classifier approaches improving. With the high-resolution images' using in many departments, this method will have a fast development.

REFERENCES

[1] WEN Wo-gen High Resolution IKONOS Satellite Images and Production Speciality(J) REMOTE SENSING INFORMATION, 2001, 1: 37～ 38.

[2] DU Feng-lan, Object-oriented Image Classification Analysis and Evaluation REMOTESENSINGTECHNOLOGYANDAPPLICATION2004,2,20～24.

[3] Sun D F , Yang J H , Liu S X. Application of High Spatial Remote Sensing Images in Land Use Classification and Change Monitoring [J] . *Transactions of the CSAE* , 2002 ,18 (2) : 160 —164.

[4] eCognition User Guider 4, Definies Imaging.

[5] Definiens-Imaging,2002.www.definiens-imaging.com.