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 use geometry and structure information. It can provide an accessible and truly revolutionary approach. Using Beijing Spot 5 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; Spot 5; 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]. However, the traditional pixel-based classification methods can't satisfy high-resolution images' classification precision and produce large data redundancy.

Object-oriented information extraction depends on spectrum character and geometry and structure information [3]. It can provide an accessible and truly revolutionary approach. This approach interprets an image is not represented in single pixels, but 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 attribute. It provides a whole bundle of innovative features and techniques for automated image analysis [3][4]. It classifies not single pixels, but rather image 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 Spot 5 high-resolution image.

II DATA DESCRIPTION AND EXTRACTION PROCESSION

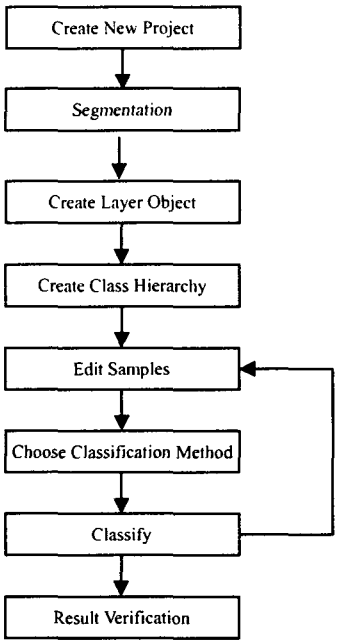
The available IKONOS image was acquired in August of 2002 .The spatial resolution is high up to 2.5m. In this paper we select Beijing east-north 1024*1024 sub-zone [Fig 1]. And we use eCongnition software with object-oriented information extraction method to classify cultures accurately.

[Fig 1]The IKONOS image to classify

The flow chart is as follows[Fig 2].

The image segmentation parameters' setting is based on the basic rules and can debug again and again. Finally, 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 result of segmentation achieves good effect[Fig 3]. After segmentation, the image objects of interest and the culture polygon are produced. [Fig 4]. Here, we can see that the layer objects' characters include not only pixels values, but also grain, size and shape information.

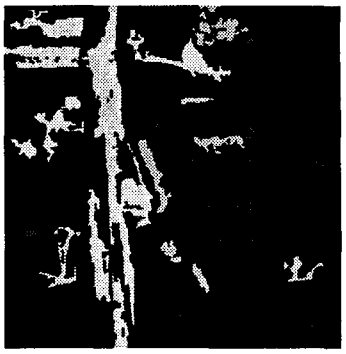
This area mainly includes water, vegetation, road, building and bare lands. The layer object hierarchy is based on these five cultures. And it provides the base for classification. Each culture is put difference color. Assign samples to determine which class an object belongs to. Select samples from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



[Fig 2] The classification flow chart

[Fig 3]The segmentation image

[Fig 4]The map of culture polygons



[Fig 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[Fig 6][3].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

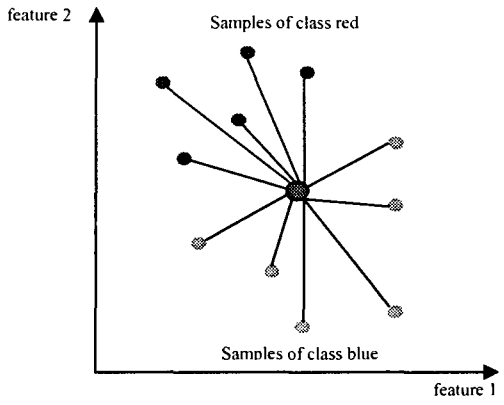
$$d = \sqrt{\sum_f \left[\frac{v_f^{(s)} - v_f^{(o)}}{\sigma_f} \right]^2}$$

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

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

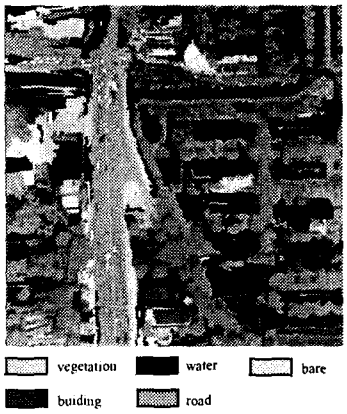
$v_f^{(o)}$:feature value of image object for feature f,

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



[Fig 6] The principle of nearest neighbor classification

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 [Fig 7].



[Fig 7]The final classification result by eCognition

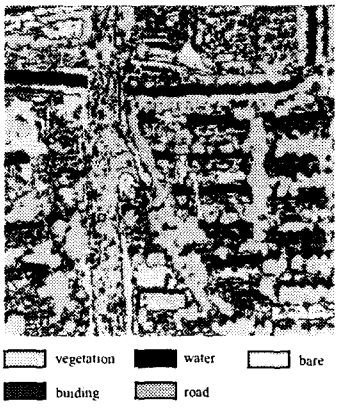
III Verification of Results

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 1 The table of classification result assessment by eCognition

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 (ML) classification to classify the test area and assess its classification result(Fig 6,Table 2).



[Fig 8]The result of Classification by maximum likelihood

Table 2 The table of 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					

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

IV Conclusions and Discussion

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

However, there are still some questions in object-oriented information extraction. We should study carefully the relationship of image and segmentation scales, the classification application in dynamic change inspection, the extracted information combination with GIS and so on.

In conclusion, this is a big step forward in remote sensing image information extraction[4]. With the high-resolution images' using in many departments, this method will have a fast development.

V References

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