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EXPLORE OBJECT-ORIENTED CLASSIFICATION FOR LAND USE FROM HIGH RESOLUTION SATELLITE IMAGERY

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ABSTRACT

Land use is an indispensable prerequisite for credible causes and consequences investigation of global environment changes. With the increasing availability of very high resolution remote sensing imagery, more accurate and effective analysis of land use is becoming possible. However, the traditional method of imagery interpretation is focused on pixel-based analysis, which has fundamental limitations in addressing particular land use characteristics due to finite spatial extent. Taking advantage of recent advances in imagery interpretation methods, a supervised procedure based on object-oriented image analysis, is proposed in this study to reduce manual labor and objectify the choice of significant object features and classification thresholds. A sequence of image segmentation, feature selection, object classification and error balancing was discussed in details. In order to verify the validity of object-oriented Classification for high resolution satellite imagery, a scene of 2.4-meter multispectral image of Quickbird is respectively classified by the pixel-based analysis from Erdas and the object-oriented method from eCognition. It can be concluded by comparison that the object-oriented classification is better fit to exact the land use information from high resolution remote sensing imagery than the pixel-based method.

Keywords: *High Resolution Satellite Imagery, Object-oriented Classification, Land Use, Ecognition, Remote Sensing*

1. INTRODUCTION

In recent years, with the development of space remote sensing technology, high resolution remote sensing imagery has been increasingly used to carry out the land use research[1,2,3]. Compared with the high spectral resolution data and multi-spectral resolution data, it has abundant spatial information, more distinct features of the geometry structure and texture, less wave band and other advantages. However, during the procedure of image interpretation, the traditional supervised classification or unsupervised classification method focus on single pixel, which may easily lead to lower classification accuracy, a large number of spatial data redundancies and waste of resources. Obviously, it is an unavoidable problem that the traditional classification methods can not satisfy the requirements of practical application when dealing with high resolution remote sensing image. Therefore, it is extremely significant to explore an efficient and accurate image classification method.

The appearance of object-oriented classification method brings new opportunities to make up for the deficiency of the traditional technology. When classifying high resolution remote sensing image, the smallest unit existed in the image is no longer a single pixel, but one object that has the same characteristics of the "homogeneous uniform"[4]. The method can take full advantage of the spatial information, the geometric structure and texture data for images interpretation. It is not only achieving the classification efficiency, but also meeting the accuracy requirements of the image classification results in the process of conducting land use research, which is the traditional method of interpretation cannot be achieved.

In this paper, through comparing the object-oriented classification method with the traditional classification method of high resolution remote sensing image, the superiority of the former was revealed clearly. The objective of the paper was to explore the classification of land use based on the object-oriented method roundly. In addition, we

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aimed at overcoming the shortage of the traditional method, increasing the utilization rate of image information and improving the accuracy of the classification results. The discussion concentrated on the effect of two classification methods. Section 2 gave an overview of the object-oriented classification method. Subsequently, a case of comparation on high resolution remote sensing image classification between the pixel-based classification and the object-oriented classification were described in section 3. And there was discussion of object-oriented classification method in details in section 4. The conclusions were presented in section 5.

2. OVERVIEW OF OBJECT-ORIENTED CLASSIFICATION

2.1 The basic principle

Object-oriented classification method comprehensively considers many factors, including the ground spectral features, geometric features and structure characteristics[5]. Compared with the traditional classification methods, its characteristics are mainly reflected in the extraction of both spatial and spectral information in the image. The smallest unit of image is no longer a single pixel, but the meaningful image objects which are the foundation of the subsequent image analysis and processing.

2.2 The image segmentation

Image segmentation is the process of refining the images into separated regions. In the object-oriented method, multi-scale image segmentation are basically used. Multi-scale image segmentation begins with the arbitrary pixels, and uses the top-down method of region merging to form the object in order to create the image object hierarchy structure. Each image object has superior objects and lower objects. When dividing the image, it obeys the following rules: pixel layer and the image of the object should be considered as two special layers, and the division of any object layer is formed between them. The objects formed under large-scale division are produced by combinations of objects formed under small-scale division[6].

2.3 Image classification and attribute extraction

Each image object has a lot of attribute information which is called Object features. The attribute information is divided into four groups, including layers, shape, texture and structure. Among them, the layer properties is the most common which represents the average of all pixels within the same image object, so it is called mean[7,8,9]. The other properties include different channels and the ratio of different levels. For example, the aspect ratio, which is the most commonly used when describing the shape features, and other such as size, direction, asymmetry and so on. Shape index fully reflects the advantages of object-oriented analysis, and it means that whether a single pixel or the pixel set, each image object has its own shape features, not only include size index.

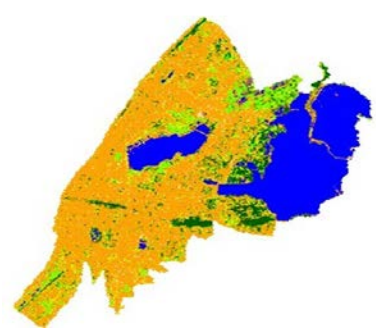
3. CASE STUDY

3.1 Data source and pre-processing

In this study, the basic data mainly selected is QuickBird image of Wuhan in 2002 and the study area is Wuchang District intercepted artificially. QuickBird is a high-resolution commercial earth observation satellite which launched in October 2001 on a Boeing Delta II rocket from Vandenberg Air Force Base, Calif, and it collects panchromatic (black & white) imagery at 60-70 centimeter resolution and multispectral imagery at 2.4- meter and 2.8-meter resolutions[10]. Data pre-processing includes the projection conversion, the image registration and the image cutting.

3.2 Traditional land classification information extraction

In order to highlight the accuracy advantage of object-oriented classification method compared with traditional methods, we used the traditional method supervised classification to conduct image interpretation for the study area based on the data pre-processing. Through establishing the template (the training sample), evaluating the template, determining the initial classification results, testing classification results, conducting classification post-processing, counting classification features and carrying out the conversion between raster and vector, we extracted 6 categories of land use types: unused land, forest, grassland, arable land, construction land and water. The results of land information classification for Wuchang district is shown in Fig. 1(a).



(a)

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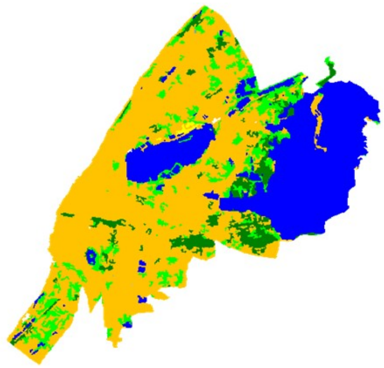


(b)

Fig.1: The Results of Classification of Quickbird Remote Sensing Imagery in 2002: (a) The Pixel-based Cassification from Erdas, (b) The Object-oriented Classification from Ecognition.

3.3 Object-oriented land classification information extraction

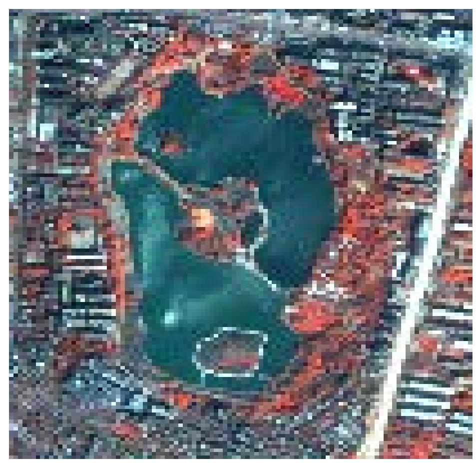
The proposed classification method is realized through eCognition software launched by the German Definiens-Imaging company. The classification process includes: (1) Creating an image object: after importing QuickBird image of Wuchang district and conducting the image segmentation, the object classification hierarchy was formed. (2) Establishing classification knowledge base: we defined the nearest neighbor classifier that eCognition software provided, and inserted the classifier into the knowledge base we have established before. (3) Classifying the image. (4) Evaluating the accuracy: the method of Best Classification Result was used to evaluate the classification shown in Table 1.

It can be seen in Table 1 that most types achieved the ideal classification, among which water reaches to the best classification value 0.9922. However, construction land exists a certain deviation in classification because of the effect other land types have made.

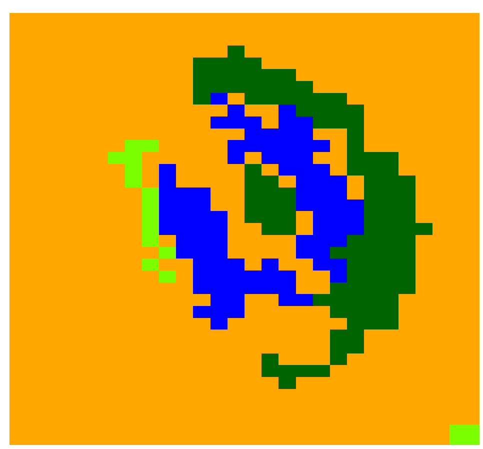
4. DISCUSSION

From the overall effect of the image classification results(Fig.1),we can intuitively see that the traditional remote sensing image classification method exists some shortage due to the processing for a single pixel, there are many small image spots in the classification image and it appears more scattered. It cannot show the integrity presence of the surface feature, especially the grass and forest. Although the traditional classification software, such as ERDAS, provides the filter analysis and remove analysis tools too, and it can remove some small image spots or merge them into the adjacent largest classification for a certain number of pixels. However, the operations are on the assumption of reducing the classification accuracy, and it means that when modifying some small image spot, it may also change other small surface features belonging the correct classification. For the object-oriented method processing results by eCognition software, the entire image appears a better globality and does not exist the image spot, which both rely on the good role the object-oriented technology playing in the classification. Before forming the object, the system will have the remote sensing image mixed together according to the pixel spectral, texture and spatial relationship properties.

In order to compare the classifications of the two methods mentioned above obviously, we intercepted Ziyang lake located in the junction of Ziyang road and Shouyi road to study specially.



(a)



(b)

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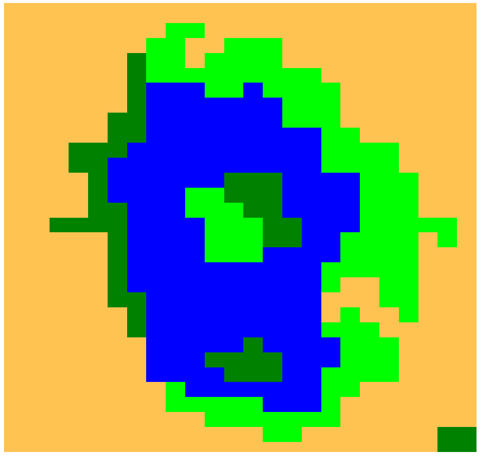

(c)

Fig.2. (a)The Remote Sensing Imagery of Ziyang Lake, (b) The Pixel-based Classification of Ziyang Lake from Erdas, (c) The Object-oriented Classification of Ziyang Lake from Ecognition.

As shown in Fig.2, we can obviously see that the object-oriented method identifies the whole Ziyang lake area effectively as a result of considering the multiple image attribute information, and forms a complete object of Ziyang lake. On the contrary, the classification from Erdas is simply a series of independent pixels, and what it forms is a scattered combination of water, which leads to inaccuracy.

5. CONCLUSIONS

In this study, we have explored object-oriented classification for land use and discovered the advantages in efficiency and accuracy compared with the traditional classification. The basic unit of the object-oriented classification is no longer a single pixel, and it not only utilizes multiscale segmentation method, but also considers the spectral features and the geometric features such as compactness and shelloniness, which can improve the utilization rate of remote sensing image information. Future developments of the object-oriented technology are directed towards how to choose the best segmentation scale and the main information to consider when classifying the high resolution remote sensing image.

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Table 1 : Evaluate The Classification of Object-oriented

Class	Objects	Mean	StdDev	Minimum	Maximum
Unused land	7	0.9140	0.0661	0.7866	1
Forest	94	0.9331	0.0557	0.7476	1
Arable land	7	0.9783	0.0272	0.9188	1
Water	97	0.9922	0.0195	0.8189	1
Grassland	405	0.9556	0.0679	0.2148	1
construction land	1179	0.9064	0.135	0.114	1