EXTRACTION OF URBAN GREEN AREA BASED ON OBJECT-ORIENTED

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ABSTRACT:

At present , with the rapid development of remote sensing technology especially the improvement of remote sensing image processing , many cities of in china and overseas have applied remote sensing to greenland information extraction ,in order to find out green area cover dynamicand optimize the spatial structure of green space.This paper takes high-resolution remote sensing image as the data source and extracts the information of the urban green area according to the method of object-oriented method . The texture feature is extracted by making use of the grey co-occurance level matrix and wavelet transform .The extraction result is compared to the traditional method to evaluate the accuracy . Study the meaning of the extraction of urban green area based on object-oriented method ,and get an effective extraction method of the urban green area .

1. FOREWORD

With the rapid development of remote sensing technology especially the improvement of remote sensing image processing , remote sensing has been applied in the various social fields more and more widely increasing .The urban green space is an important part of the ecology system , it is the result that many factors take part in ,for example, nature and humanities and so on , and it is the sign of the environment of city and the living standard of the people .In the recent years , many cities of in china and overseas have applied remote sensing to greenland information extraction ,in order to find out green area cover dynamicand optimize the spatial structure of green space. It can increase the city's potential of sustainable development and realize the planning of the green space.

Traditionally the information extraction of the remote sensing image mainly has two methods: the pixel-based approach and the manual interpretation approach .The extraction of the urban green space is based on the pixel and carries the classification and extraction according to the spectrum features. Since this technology a pixel as the unit , its result of the extraction is dispersed , so it influences the extracted accuracy seriously . Along with the development of the remote sensing technology , more and more remote sensing images with the high-resolution have been applied to the extraction of the green space in the city. The high-resolution image implies abundant texture features and spatial structure information ,so the high-resolution image processing based on pixel will produce "salt" phenomenon .The accuracy of the extraction result is lower because of the noise .

In order to achieve the information extraction of the high-resolution image , rational use the bundant information of the high-resolution image , according to the features of high-resolution remote sensing images, the object-oriented information extraction methods have emerged.

2. THEORY

The paper extracts the information of the urban green area according to the method of object-oriented method . Firstly it carries on the pre-processing to the remote sensing image , Secondly the integrate criterion of the smallest heterogeneity and the scale parameter are applied to the segmentation , it divides the image into many homogeneous regions. Thirdly extracts the texture features by making use of the grey co-occurance level matrix and wavelet transform . Then target at the segmentated image, make use of the object-oriented method to combine the textures extracted from grey co-occurance matrix and wavelet transform to classify and extract green area .

2.1 Image Segmentation

The key of the method based on object-oriented is image segmentation ,the important step is how to choose the appropriate scale of the image segmentation and extract the target .

Multi-scale image segmentation is that the same image is segmented several times with the different scales. So the ground object and structure information can be described by the s segmentation results of the different scales .Multi-scale segmentation is adopted the calculation of region growing of the smallest heterogeneity .At the process of the segmentation consiers not only the spectral characteristics but also the spatial features and the shape features(Yiqun Xiong and Jianping Wu,2006) . Spectrum factor and the shape factor can be determined at the segmenting ,and the shape factor contains the compactness heterogeneity and the smoothness heterogeneity(Zhenyong Zhang and Wang Ping,2007) .
The calculation formula of the heterogeneity f can be expressed(Xiaofang Sun and Lu Jian,2006):

$$f = w_{color} * h_{color} + (1 - w_{color}) * h_{shape} \quad (1)$$

$$h_{shape} = w_{cmpct} * h_{cmpct} + (1 - w_{cmpct}) * h_{smooth} \quad (2)$$

Here : w_{color} expresses the weight of the spectrum information ;

h_{color} expresses the spectrum heterogeneity ;

h_{shape} expresses the shape heterogeneity;

w_{cmpct} expresses the compactness weight ;

h_{cmpct} expresses the compactness heterogeneity ;

h_{smooth} expresses the smoothness heterogeneity ;

$$h_{cmpct} = n_{merge} * \frac{l_{merge}}{\sqrt{n_{merge}}} - (n_{boj1} * \frac{l_{obj1}}{\sqrt{n_{obj1}}} + n_{boj2} * \frac{l_{obj2}}{\sqrt{n_{obj2}}}) \quad (3)$$

$$h_{smooth} = n_{merge} * \frac{l_{merge}}{b_{merge}} - (n_{boj1} * \frac{l_{obj1}}{b_{obj1}} + n_{boj2} * \frac{l_{obj2}}{b_{obj2}}) \quad (4)$$

When the multi-scale image segmentation ,the scale parameter and the weight of the heterogeneity factor need testing again and again , so we will find out a suitable segmentation parameter.

2.2 FeatureExtraction

The image classification according to the spectrum features can cause the phenomenon of the same object with different spectrum easily, so it influences the extracted accuracy seriously .The high-resolutio image which has bundant texture information can solve the phenomenon of the same object with different spectrum by the texture feature , it plays an important role in improve extraction accuracy . This paper is adopted grey co-occurance matrix and wavelet transform while the texture features are extracted .

2.2.1 Extract the texture feature based on Gray Level Co-occurrence Matrix(GLCM) : The Gray Level Co-occurrence Matrix(GLCM) of an image reflect the integrative information of pixels with regard to directions and the changing extent of interval. It is the basis to analyze image textures . As the characteristic value of the texture analysis, usually can′t apply gray level co-occurrence matrix directly but calculate the characteristic value on the basis of the gray level co-occurrence matrix(Yonghong Jia,2003) . Texture characteristics of the commonly used :

(1) Angular Second Moment

$$f_1 = \sum_{i=0}^{L-1}\sum_{j=0}^{L-1} \hat{p}^2(i,j) \quad (5)$$

Angular second moment reflects the distribution of the gray scale and the texture granularity in the image .

(2) Contrast

$$f_2 = \sum_{n=0}^{L-1} n^2 \{ \sum_{\substack{i=0 \\ n=|i-j|}}^{L-1} \sum_{j=0}^{L-1} \hat{p}(i,j) \} \quad (6)$$

Contrast reflects the Image Definition .

(3) Entropy

$$f_3 = -\sum_{i=0}^{L-1}\sum_{j=0}^{L-1} \hat{p}(i,j) \log_2 \hat{p}(i,j) \quad (7)$$

(4) Deficit Moment

$$f_4 = \sum_{i=0}^{L-1}\sum_{j=0}^{L-1} \frac{\hat{p}(i,j)}{1 + (i-j)^2} \quad (8)$$

If want to extract the feature of the Rotation Invariance ,you can calculate the the gray level co-occurrence matrix of the four direction ,and calculate the average value and mean square deviation .

2.2.2 Extract the texture feature based on wavelet transform： Wavelet transform have good local time-frequency property, scale-changed feature and good directionality characteristic. That would benefit the image texture analysis . After a two-dimensional discreteness wavelt transform, the image is discomposed low-frequency sub-image 、 high-frequency sub-image of the level, vertical,diagonal direction. Then low-frequency sub-image continue to be decomposed by wavelet, we can get the sub-image of the lower layer. After the N level decomposition, we can get the sub-image which the amount is 3N+1.

The wavelet decomposition coefficients of the image(Huang Xin,2005) :

$$c_{m,n}^{(j)} = \sum_{l,k} h_{k-2m} h_{l-2n} c_{k,l}^{j-1} \quad w_{mn}^{(j,h)} = \sum_{l,k} h_{k-2m} g_{l-2n} c_{k,l}^{j-1}$$
$$w_{m,n}^{(j,v)} = \sum_{l,k} g_{k-2m} h_{l-2n} c_{k,l}^{j-1} \quad w_{mn}^{(j,d)} = \sum_{l,k} g_{k-2m} g_{l-2n} c_{k,l}^{j-1} \quad (9)$$

2.3 Greenland information extraction

While extracting the information with the object-oriented classification, the remote sensing image is segmented and becomes the homogeneous by the calculation of region growing, combine the grey co-occurance matrix and the wavelet transform respectively. The texture sample of the greenland is a feature vector to carry on match and extract the greenland information .

3. EXPERIMENT

In experiments, the high-resolution aerial image as the data source of the Fuxin. Its resolution is 0.6m. The image segmentation uses of eCognition, combines the texture feature by the grey co-occurance matrix and the wavelet transform, extracts the green area.

3.1 Select the suitable segmentation parameter

While the segmentation ,the judgement criterion is the smallest heterogeneity principle that contains the spectrum information and the shape information. If the heterogeneity between the two closed regions is very small , they are very similar. The scale parameter needs testing again and again , so we will find out a suitable segmentation parameter.

Figure 1. The original image

Figure 2. The segmentation image

Figure 1 the effect graph of the segmentaion image

3.2 Adopted grey co-occurance matrix and wavelet transform while the texture features are extracted

3.2.1 Extract feature used grey co-occurance matrix：

(1)The first step is that the multiband image transformes into gray image , obtains the single band image, choose a band to calculate the texture feature. Because the texture feature is a structure feature , the result is the same. (2) Secondly, the gray scale level quantization of the image(Jianhui Feng,2007). The gray scale level is 256 in a image, it results in the grey co-occurance matrix too large. In order to resolve this problem, the gray level is compressde to 16 levels. (3) Select the window size and the steplength, and calculate the mean value of the four directions, only this it will have rotation invariance.

3.2.2 Extract feature used wavelet transform：

How to choose wavelet and analyze its levels is also of great importance when wavelet transform is used to extract texture information. The Daubichies4 wavelet is used in the experiment, the image should be decomposed into 3 levels by wavelet transform, extract decomposition coefficients of the low and high frequency, as the texture feature.

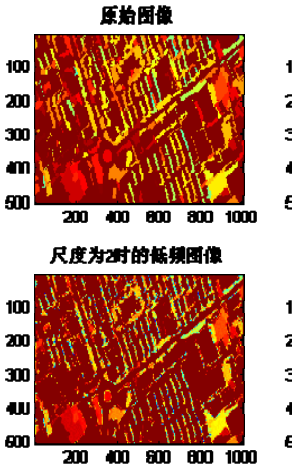

Figure 3. The low frequency sub-image

Figure4. The high frequency sub-image which the decomposition level is one

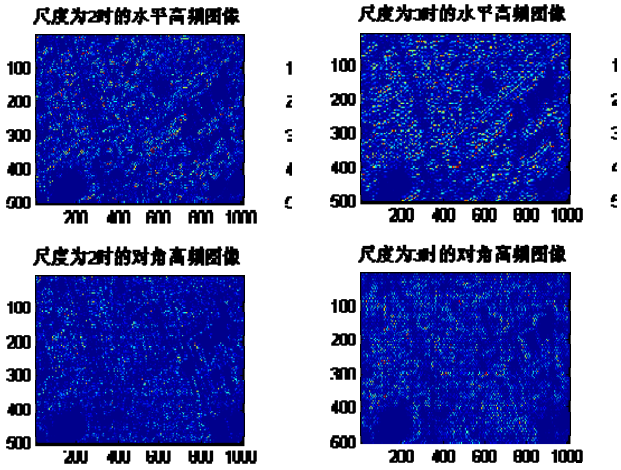

Figure5. The high frequency sub-image which the decomposition level is two

Figure6. The high frequency sub-image which the decomposition level is three

3.3 Classification according to the texture feature, and extract the greenland information

The feature vector is the texture feature which is extracted by grey co-occurance matrix and wavelet transform, and apply to supervised classification, make use of the minimum distance classifier. The results of the greenland informatin extraction :

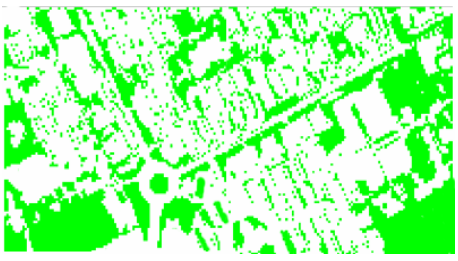

Figure7. Extraction by grey co-occurance matrix

Figure8. Extraction by wavelet transform

3.4 Precision assessment and Accuracy analysis

In order to explain the problem, the result of the greenland area extraction is compared to the traditional method and analyze the accuracy. The total accuracy with the object-oriented method combines the grey co-occurance matrix is 87.20%, the total accuracy with the object-oriented method combines the wavelet transform is 89.15% ,the total accuracy of the methods based on pixel and spectrum. is 76.25%.

By comparison of the result, we can find that : the extraction method based on pixel, its result of the extraction is dispersed , noise severely, so it influences the extracted accuracy seriously, the extraction result based on object-oriented, at the process of the segmentation consiers not only the spectral characteristics but also the spatial features and the shape features, it avoids the "salt" phenomenon, and the result is integrated relatively, so the accuracy is higher, it accords with the objective conditions.

4. CONCLUSION

This paper paper takes high-resolution remote sensing image as the data source and extracts the information of the urban green area according to the method of object-oriented method, combines grey co-occurance matrix and wavelet transform. Then the result of the greenland area extraction is compared to the traditional method, we can find that this method can make fully use of the information of the high-resolution image, it's very good of superiority to extract green area for high-resolution remote sesing image.

REFERENCES

Yiqun Xiong,Jianping Wu,2006. Research on Detection of Urban Vegetation by Object-Oriented Classification . The Journal of East China Normal University. 7(4),pp.84-90.

Zhenyong Zhang, Wang Ping, Zhu Lu, Xiangling Chen, 2007. Application of the Recognition Technology to Information Extraction from High Resolution Remote Sensing Image. Information Technology. 2(15),pp.15-17.

Xiaofang Sun, Lu Jian, Xiaodan Sun, 2006. Extraction of Green Space in Urban High Resolution Remote Sensing Image. remote sensing technology and application 21(2),pp.159-162.

Yonghong Jia, 2003. Digital Image Process .pp.182-184.

Huang Xin, Peiliang Zhang, Cuilin Li, 2005. Experiments to Extract Texture Features of Images Based on Wavelet. Surveying Information and Engineering. 30(6),pp.7-9.

Jianhui Feng, Yujing Yang, 2007. Study of Texture Image Extraction Based on Gray Level Co-Occurance Matrix. Beijing Surveying and Mapping. pp.19-22.

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