Study on Classification of Land Use Based on TM\ETM+ Image

Mengtong Li
Northeast Normal University
Jilin, China

Xiaojing Sun
Northeast Normal University
Jilin, China

Lingbin Yang*
Northeast Normal University
Jilin, China
*Corresponding author

***Abstract*—The use of remote sensing classification technology can quickly obtain land use change information. Supervised classification and classification method, In the study area, the change of land use was analyzed. The classification effect depends on the classification scheme. The main purpose of this paper is to discuss several processing methods of computer classification based on the TM image. Draw general conclusions: (1) the classification accuracy of KL is higher than that of IHS fusion image. But the calculation of the relative IHS method is large and the calculation time is long. (2)Using the KL transform to achieve the purpose of data compression, but also to improve the visual selection of the training needs of the field.(3) The fusion image has the advantages of multi spectral and high spatial resolution, which is beneficial to improve the accuracy of the image recognition and interpretation, and then improve the classification accuracy.**

Keywords- land classification; image processing

I. INTRODUCTION

Land is the material basis of human life, but also people of all social and economic activities in the most basic of material. Because social development and adjustment of industrial structure, the proportion of each land sector also will change in land use from time to time updated[1]-[2]. Remote sensing information for its coverage area and now the potential of real-time, strong speed, fast cyclical and accurate, as well as save time and effort and low cost, has been widely used to investigate changes in land use and land resources to monitor land use and other aspects

Computer remote sensing image classification is a computer pattern recognition technology in the field of remote sensing of specific applications, its core mission is to identify the different interfaces and standard discrimination between categories of land, good repeatability, high positioning accuracy, processing time is short, timeliness, has is widely used in remote sensing, land use survey.

II. AN IMAGE PRE-PROCESSING AND DATA PREPARATION

A. Data Sources

The data source of this study is the TM image in Beijing, a total of three King (ETM including 1-7 and panchromatic band), an area of 185 × 185 km, this time phase studies in September 1992, July 1999 and August 2013.

B. To Determine Classification Categories

Due to the limitations of the resolution of TM data, the classification category is limited, integrated land use classification system, before several major categories of the pre-classification as follows: vegetation (including: trees, shrubs, etc.), farm (all kinds of arable land), water (includes: lakes, ponds, rivers, etc.), buildings (including: Urban land, rural settlements, etc.)

C. Geometric Correction

Geometric correction principle: digital correction of remote sensing images is completed by computer graphics for each pixel individually correct parsing process, it is possible to correct distortion error of linear and non-linear accurately distortion. It includes two aspects: First, the pixel coordinate transformation, the second is the pixel gray value revamping[3]-[4].

Correction Implementation: As the image data of this experiment, the 1992 TM image was corrected image, therefore, the use for the 1992 TM image as a reference image, corrected ETM images in 1999 and 2013.

Control point accuracy is maintained within a pixel precision, part of the control points in the following table shows: The following table (Table 1) as part of the test selected control point data, the error is less than one pixel.

TABLE I. CONTROL POINT PRECISION TABLE(PART)

	Table Column Head						
	Base X	***Base Y***	***Warp X***	***Warp Y***	***Error X***	***Error Y***	***RMS***
1	3308.2500	5226.2500	2855.5000	4841.0000	0.23525296	-0.14731590	0.27757148
2	1679.2500	3191.7500	1051.2500	3141.2500	0.55583626	-0.17680019	0.58327717
3	933.00000	3968.7500	451.50000	3970.5000	0.58185696	-0.13058684	0.59633081
4	6181.7500	7264.5000	5830.7500	6379.5000	0.40802562	0.13642370	0.43022823
5	4724.2500	2731.0000	3858.5000	2307.2500	0.32996971	-0.15294876	0.36369401
6	4920.5000	5698.2500	4436.5000	5072.5000	-0.077521359	0.049058392	0.091740324
7	5057.2500	3190.7500	4234.0000	2696.0000	-0.66403883	-0.21829184	0.69899850
8	2698.2500	2407.5000	1908.2500	2268.7500	-0.64712988	0.42361273	0.77344995
9	7524.2500	1470.0000	6329.2500	752.75000	0.39077309	0.13845638	0.41457663
10	7022.0000	4870.2500	6305.2500	4017.0000	0.58287391	-0.025419973	0.58342794

III. RESEARCH ON THE LAND CLASSIFICATION OF TEST AREA

A. Image Data Analysis

In this study all image data were: TM images of 1-7 panchromatic bands in September 1992 band, ETM images of 1-7 panchromatic bands in July 1999 and the panchromatic band, ETM image in the 1-7 band and full color band in August 2013

TM data effectively in order to use image classification of TM data and thematic information extraction, It carefully analyze the characteristics of remote sensing data[5]-[6]. TM data has 7 bands. The 6 band has low resolution, not adopted in this study. 1992, 1999 and 2013 in the study area TM \ ETM data of six bands (except the 6th band) statistical analysis of information characteristics shown in the table :(Table 2-- Table 3) as the following

TABLE II. STATISTICAL INFORMATION OF EACH BAND IN 1992 TM

Band	Table Column Head			
	Gray Min	***Gray Max***	***Mean***	***Standard deviation***
Band 1	0	150	24.259790	8.739153
Band 2	0	96	15.544646	5.080482
Band 3	0	157	19.567312	8.127583
Band 4	0	214	48.481752	14.785657
Band 5	0	248	53.490584	11.207655
Band 7	0	252	24.956611	8.555788

TABLE III. TABLE TYPE STYLES

	Table Column Head					
	Band 1	***Band 2***	***Band 3***	***Band 4***	***Band 5***	***Band 7***
Band 1	1.000000	0.948470	0.952452	-0.458299	0.279155	0.773712
Band 2	0.948470	1.000000	0.967038	-0.318250	0.413100	0.825546
Band 3	0.952452	0.967038	1.000000	-0.443548	0.402168	0.875484
Band 4	-0.458299	-0.318250	-0.443548	1.000000	0.400102	-0.264765
Band 5	0.279155	0.413100	0.402168	0.400102	1.000000	0.699906
Band 7	0.773712	0.825546	0.875484	-0.264765	0.699906	1.000000

1992: According to the grayscale range and standard deviation, In TM1,2,3 band, 1 band and 3-band standard deviation is large, the information is amount of abundant; In TM5,7 bands, 5-band standard deviation is large, the information abundant amount. According to the correlation coefficient, the 5-band and 1,2,3-band correlation coefficient is less than seven bands significantly, and with 1 band of the least relevant. Select 5-4-1 combination bands for false color composite. Get natural color similar to a combination of bands false color image, the image used for classification as a classification test.

1999: The same consideration. TM1 2 3 band, the amount of information for 1 <2 <3; TM5 7 band roughly the amount of information. However, according to relativity, first of all Select 5 5 7 band in band, the first group associated with the 5-band low level for 1 band. Comprehensive consideration, select false color composite 5-4-1 band combination.

2013: The same selection 5-4-1 band. In addition, we calculate the best waves based on the best index formula (OIF) Professor Charles Horowitz US proposed algorithm combinations:

$$OIF = \frac{\sum_{i=1}^{n} Si}{\sum_{i=1,\ j=1}^{n} \left| r=i,\ j \right|}$$

Si for i-band standard deviation; Rij for i, j correlation coefficient between the band, the more OIF greater the more optimal band combinations[7]-[8].

According to the results obtained for the best band combination 7-5-1, 5-4-1 and 7-5-4 and then, after a relatively decided to choose the color composite 5-4-1 band combination scheme.

B. Discussion on the Classification of Image Generated by Different Methods

1, 1992: As the absence of a high-resolution panchromatic image, in the case of false color composite of the band the best combination image as a classification underlay.

2, 1999: extract the best band combination, using IHS transform method generate classification underlay image.(Note: Before IHS transform To multispectral images were resembled in panchromatic spatial resolution unanimously.)

3, 2013: using the generated image fusion method based on classification underlay KL transform. (Note: And TM multispectral image resample consistence panchromatic image resolution before KL transformation.)

C. Classification

After a series of processing above, has been gated the various under the classifications treatment options, the following work is to implement classification. According to pre-set categories, each category: vegetation (including: trees, shrubs, etc.), farm (all kinds of arable land), water (including: lakes, ponds, rivers, etc.), buildings (including: urban land, rural residents points, etc.), and roads[9].

- After various test classification methods (including supervised classification and unsupervised classification), found that polygons messy after unsupervised classification, misclassification is seriously, and the operation is very difficult. Therefore, the study use supervised classification methods. Using the maximum likelihood method supervised classification. Respectively in 1992, 1999 and 2013 under the classifications select to training area
- First of all, select the training area, TM image, due to the low resolution a several of land use boundaries become blurred, easy to distinguish the boundaries around the class. Supervised classification, in order to ensure consistency of accuracy assessment, in the TM image around the first choice as a standard to be classified, in the same location as the basis of the change did not happen on the integration of the image, in Figure 5-10 training.

D. Post Classification Processing

- By After calculation, the overall classification accuracy and Kappa coefficient of each year in the following table (Table 4) [10]-[11]

TABLE IV. CLASSIFICATION ACCURACY AND KAPPA COEFFICIENT

	Table Column Head		
	1992 year	***1999 year***	***2013 year***
The correct pixel number of interest area	9043	21872	21181
Total pixels of interest area	12568	27286	25227
Overall classification accuracy	71.9526 %	80.1583%	82.8546%
Kappa coefficient	0.6693	0.7819	0.8047

- As can be seen using the two years after fused image are higher than 8.2057% and 10.902%, respectively, compared TM541 color composite image classification accuracy, Kappa coefficient ratio based higher than 0.1,compared TM false color composite image.
- According to evaluate the accuracy of the foregoing, got three image classification accuracy results. Obviously, the two fusion images automatic classification results were higher than the TM541 false color composite image, compared with the TM541 images classification results, IHS and KL image fusion method the classification accuracy increased by 8.21% and 12.01%.
- TM spatial resolution is relatively low, in many cases, a various of land use types, automatic classification process caused by the misjudgment of computers, especially for small pieces boundaries are lost, so the overall classification Accuracy is only 71.9526%; new image fusion not only retains characteristics of the image TM multi-spectral, but also increases the texture of a space full-color images, statistics also smaller plots of land type classification accuracy is greatly improved.
- Comparison of two different fusion methods, IHS fusion can only choose three spectral bands and panchromatic image fusion experiments to select the best combination of TM1,4,5 band spectral information; KL fusion band TM6 band relatively PC1, PC2, PC3 components Information fusion image contains relatively, so KL fusion image classification accuracy relative IHS image fusion automatic classification capabilities. Moreover, the use of the original image by the first three principal components KL transform attend classify calculations, combined with panchromatic image fusion bands, both the required information can be centralized to achieve the purpose of data compression, and can improve visual selection training accuracy area.
- However, KL transform to change the physical meaning of each component, the integration of visual effects is lower than the IHS fusion effects, larger and larger amounts of data to calculate and the amount of time required for the calculation and longer..

IV. CONCLUSION

The experiment with TM in Beijing \ ETM images for the study of images, through image analysis and processing, show to use the remote sensing images the process of land use classification. By comparing between different classification schemes analysis, get the characteristics and their respective advantages and disadvantages. Through experiments, we can draw the following conclusions:

1 A remote sensing technology compared to traditional method for land use survey is a very more viable, more efficient and economical way. And TM image resolution mapping of its short cycle, a large area, low cost characteristics, has unique advantages in terms of land use.

2 multi-band image data classification and information extraction, the need for multi-band characteristics statistical data analysis, , in order to more effectively utilized extracting the best band combination

3 image fusion technologies can improve the classification accuracy. Compared to TM image classification accuracy TM image and panchromatic image fusion is greatly improved. Multispectral image fusion has the features and advantages of the high spatial resolution, will help improve the accuracy of image recognition and interpretation, and thus improve the classification accuracy.

4 using the KL transform of the first three principal components of the original image calculated participation classification, combined full-color image fusion, not only to achieve the purpose of data compression, but also can improve the field of training information to visually select desired accuracy.

5 To compared IHS fusion image classification accuracy because only three bands TM image fusion, image relative with multiple TM spectral band image KL information transformer less amount of information fusion image, KL classification accuracy higher than IHS fused image. But IHS method need large computation and long computational time.

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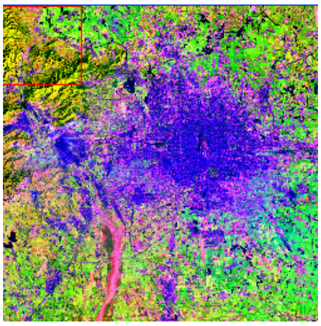

FIGURE I. PRE CLASSIFICATION (1992)

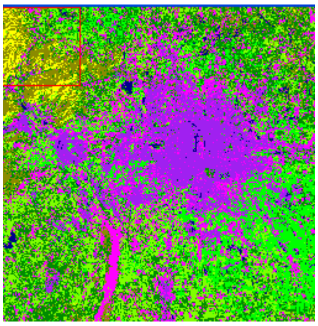

FIGURE II. AFTER CLASSIFICATION (1992)

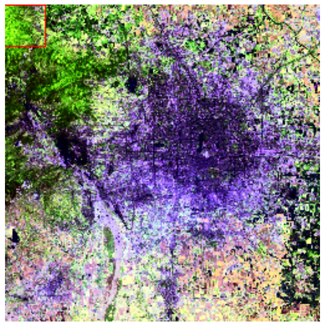

FIGURE III. PRE CLASSIFICATION（1999）

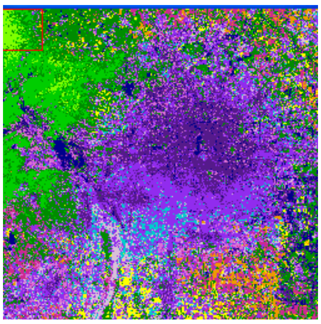

FIGURE IV. AFTER CLASSIFICATION(1999)

FIGURE V. PRE CLASSIFICATION(2013)

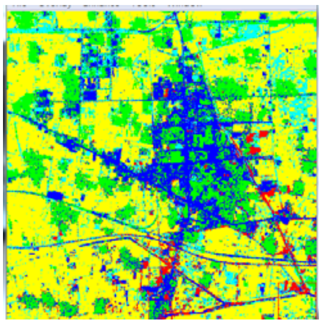

FIGURE VI. AFTER CLASSIFICATION(2013