

ACCURACY EVALUATION ON FUZZY SET CLASSIFICATION METHOD FOR HIGH SPATIAL RESOLUTION REMOTE SENSING DATA

Shuhe ZHAO^a, Shijie XIE^b, Xinming ZHANG^c, Chunhong WANG^a, Wei TANG^a

^a Department of Geographical Information Science, Nanjing University, Nanjing 210093, China

^b Nanjing Urban Planning Bureau, Nanjing 210029, China

^c Weifang Institute of Surveying, Mapping and Geotechnical Investigation, Weifang 261041, China

KEY WORDS: Fuzzy set, Classification, High spatial resolution remote sensing data

ABSTRACT:

In the paper, a novel method for high spatial remote sensing data classification was put forward. The method was based on fuzzy set theory combined with NDVI. The classification experiments were carried out by the pan-sharpened multispectral QuickBird image. Then the classification process was given using the combined NDVI image with multispectral QuickBird image. The fuzzy set theory could solve the uncertainty of remote sensing information well. Accuracy evaluation on the experiment results was given. We concluded that the classification method based on fuzzy set theory was helpful for the classification accuracy of the final result. The hybrid method had higher classification performance.

1. INTRODUCTION

High spatial resolution remote sensing data were received much more in recent years. It includes IKONOS data, SPOT-5 PAN data, QuickBird data, etc. They have been used in urban remote sensing, urban planning, precision agriculture, etc. The moderate-spatial resolution remote sensing data (e.g., Landsat TM data, SPOT-4 data, CBERS-1 data, etc) didn't satisfy the application of the satellite images over urban areas. High spatial resolution remote sensing data processing became one of the focus and difficulty in remote sensing field since 1990s. The common software systems (for examples, ERDAS Image, ENVI, PCI, etc.) face more problems for the high spatial resolution remote sensing data, because high spatial resolution data have much more information. Therefore the research of high spatial resolution processing methods is very important for the application of high spatial resolution data.

The high spatial resolution image (e.g., IKONOS image) have been classified using fuzzy theory by A. K. Shackelford and C. H. Davis [1][2] and a hopfield neural network by A. J. Tatem, et al. [3]. In addition, a wavelet transform based method for road extraction from high-resolution remotely sensed data have been investigated by T. Chen, et al. [4]. High-resolution urban imagery was analyzed using morphological segmentation method by M. Pesaresi and J. A. Benediktsson [5]. Fuzzy classification techniques allow pixels to have membership in more than one class and therefore better represent the imprecise nature of the data [2]. The approach presented in the

paper utilizes both the pan-sharpened multispectral image and the NDVI image. The pan-sharpened multispectral image are first classified by the fuzzy classifier. The pan-sharpened multispectral and NDVI images are then classified by the fuzzy classifier. Accuracy evaluation on the two classification results are carried out. Because the vegetation information is great over the urban areas, so it may influence the classification results. At the same time, extraction of the vegetation information are given using the different images.

The paper structure is as follows. The fuzzy classifier using the different images are described in section 3. The accuracy evaluation on the classification results and the vegetation information results are given in section 4.

2. DATA SET AND STUDY SITE

The QuickBird standard data consisted of one panchromatic image at 0.61-m resolution and four multispectral images at 2.44-m resolution, which were acquired on 2007-07. The QuickBird imagery was radiometrically corrected, sensor corrected, and geometrically corrected. Pixels were also recorded in 11 bits. The pan-sharpened multispectral image was gained by pan-sharpening processing of the one panchromatic image and four multispectral images. The specifications of spectral wavelengths and spatial resolutions for QuickBird imagery [6] are listed in Table 1.

	Panchromatic (nm)	Blue (nm)	Green(nm)	Red(nm)	Near IR (nm)	Spatial resolution
QuickBird Standard	450–900	450–520	520–600	630–690	780–900	0.61m(Pan), 2.44m(Multi)

Table 1 Spectral and spatial resolution of QuickBird image

The study site is located in northeast of Nanjing city, China. There are much more vegetation information in this area. It includes part of Xuanwu Lake and part of Zijin Mountain. Field investigations have been carried out by GPS mapping. Based on this background information, six land cover types were chosen for the classification, including water, tree, building, grass, road and bareland. The pan-sharpened multispectral QuickBird image shows in Fig.1. The size of the study area is 2000×2000 pixels.



Figure.1 The pan-sharpened multispectral QuickBird image

3. FUZZY CLASSIFICATION METHOD

The definition of the urban land cover information is clear in the pan-sharpened multispectral image of the study area. So the land cover types were split to more small types for the different six types. Then the small types were combined in the classification result. The pan-sharpened multispectral image was first classified by supervised classification technique. At the same time, the distance file was produced. According to the distance file, the classified image was classified by the fuzzy classifier. The fuzzy classification image is shown in Fig.2.



Figure.2 The fuzzy classification image from the pan-sharpened multispectral QuickBird image

The vegetation information is the main land cover type over the urban areas. So the classification scheme was considering the NDVI image. The NDVI image combined with the pan-

sharpened multispectral QuickBird image is shown in Fig.3. From Fig.3, the land cover types are obviously each other. Especially the tree and grass information are much more clear. The combined NDVI image with multispectral QuickBird image was classified by the fuzzy classifier also. The fuzzy classification image is shown in Fig.4.



Figure.3 The combined NDVI image with multispectral QuickBird image



Figure.4 The fuzzy classification image from the combined NDVI image with multispectral QuickBird image

4. DISCUSSION

Some land cover types were confused in the fuzzy classification image from the pan-sharpened multispectral QuickBird image (Fig.2). The single classification type was cracked. The water was confused with the stadium areas. From Fig.2, some land cover types were classified mistakenly in the right-down and the left-middle of the image.

From Fig.4, the classification types were holistic in the image. The water wasn't confused with the stadium areas. The road was well detached from the building. The classification accuracy of the fuzzy classification image from the combined NDVI image with multispectral QuickBird image was higher than that of the fuzzy classification image from the pan-sharpened multispectral QuickBird image.

In conclusion, the known knowledge of the land cover types help to the land cover classification over the urban areas. The

NDVI image was imported to the classification process, it was distinct.

ACKNOWLEDGEMENT

The study was supported by the Surveying and Mapping Natural Foundation of Jiangsu Province (No.JSCHKY200703) and the National Science Foundation of China (No.40501047).

REFERENCES

- [1] A. K. Shackelford and C. H. Davis, "A fuzzy classification approach for high-resolution multispectral data over urban areas," in *Proc. IGARSS*, vol. 3, Toronto, ON, Canada, June 24–28, 2002, pp. 1621–1623.
- [2] A. K. Shackelford and C. H. Davis, "A Hierarchical Fuzzy Classification Approach for High-Resolution Multispectral Data Over Urban Areas," *IEEE transactions on geoscience and remote sensing*, vol. 41, no. 9, pp.1920-1932,2003.
- [3] A. J. Tatem, H. G. Lewis, P. M. Atkinson, and M. S. Nixon, "Super-resolution mapping of urban scenes from IKONOS imagery using a hopfield neural network," in *Proc. IGARSS*, vol. 7, 2001, pp. 3203–3205.
- [4] T. Chen, J. Wang, and K. Zhang, "A wavelet transform based method for road extraction from high-resolution remotely sensed data," in *Proc. IGARSS*, vol. 6, Toronto, ON, Canada, June 24–28, 2002, pp.1621–1623.
- [5] M. Pesaresi and J. A. Benediktsson, "A new approach for the morphological segmentation of high-resolution satellite imagery," *IEEE Trans. Geosci. Remote Sensing*, vol. 39, pp. 309–320, Feb. 2001.
- [6] Le Wang, Wayne P. Sousa, Peng Gong, Gregory S. Biging, Comparison of IKONOS and QuickBird images for mapping mangrove species on the Caribbean coast of Panama, *Remote Sensing of Environment*, 91, pp. 432–440, 2004.

