ELSEVIER
Available online at www.sciencedirect.com
SciVerse ScienceDirect
Procedia Earth and Planetary Science 2 (2011) 352 – 357
Procedia
Earth and Planetary Science

The Second International Conference on Mining Engineering and Metallurgical Technology

Research on segmentation scale of multi-resources remote sensing data based on object-oriented

LIAN Lian[a], CHEN Jianfei[b], b*

[a,b]School of Geographical Science, Guangzhou University, Guangzhou, 510006, China,

Abstract

To verify a method of choosing the optimal segmentation scale, the Guangzhou Higher Education Mega Center is selected as test area for surface features extraction. Buildings, roads, waters and vegetations are extracted from 4 different resolution images using different scales. It is found that the optimal segmentation scale selected based on standard deviation of the means and mean of standard deviations of image objects' brightness is almost consistent with the optimal segmentation scale selected based on actual classification. The classification accuracy is related with spatial resolution. But for specific applications, higher resolution doesn't definitely get better classification accuracy.

Keywords: Remote sensing image interpretation; object-oriented method; segmentation scale; optimal scale; classification accuracy

1. Introduction

With the rapid development of remote sensing, the spatial resolution of image improves from km to m, and even cm, so that people could obtain very rich information. Facing to such vast amounts of data[1], to extract the interest area information from high-resolution images in a fast and high-precision way according to the characters of images, object-oriented remote sensing image analysis techniques is widely used in interpretation of remote sensing image currently, and better than the traditional pixel-based technology. Objected-oriented extraction is the precondition for multi-scale segmentation and optimal

*Corresponding author. Tel.: +86-20-393-66890; fax: +86-20-393-66890.
E-mail address: cjf@gzhu.edu.cn

doi:10.1016/j.proeps.2011.09.055

scale choosing. The key step for object-oriented method is segmentation scale. The size of image object and accuracy of extracted information are determined by the choice of scale. That is, there is an optimal segmentation scale for specific applications.

2. The image analysis technology based on object-oriented

Pixel-based classification is fit for low-resolution remote sensing images with rich spectral information, but for high-resolution remote sensing images, there are some problems: (1) the spectral heterogeneity among similar features increased with the improved spatial resolution, it is difficult to distinguish the surface features with different spectral properties; meanwhile, the spectral heterogeneity of different features is reduced and it is difficult to distinguish the surface features with it[2]; (2)there are large amount of data in high-resolution remote sensing images, so the traditional methods cannot meet the rapid extraction requirements; "the higher the spatial resolution is, the stronger the ability to identify objects will be; but in fact, the identification of objects in images is not only dependent on the specific value of spatial resolution, but also its shape, size and relative differences in brightness and structure of the surrounding objects[3]". The concept of scale in object-oriented analysis is no longer the pixel size, but scale segment of image, and the minimum threshold of the heterogeneity of image objects.

By the method of object-oriented, this paper extracted urban surface features from remote sensing images with different spatial resolutions, and researched the existence of optimal segmentation scale in classification of remote sensing image. That is, there is an optimal segmentation scale for particular applications, which can lead to the highest overall classification accuracy by clear polygon segmentation boundaries of features and multiple display of these features with one or more objects. Currently there are several objected-oriented optimal scale selection methods, such as Average Local Variance method [4] and the Maximum Area method [5], Ratio of Mean Difference to Neighbors to Standard Deviation (RMAS) [6], Standard Deviation of Brightness Means (hereinafter referred to as SDOM) and the Mean of Standard Deviations (hereinafter referred to as MOSD)[7], and so on.

Following the best classification principle of "homogeneity within object, heterogeneity among objects[8]", this paper uses minimum MOSD and maximum SDOM of objects' brightness as the main evaluation index to decide best segmentation scale.

A smaller MOSD indicates less difference in internal conditions of image objects, and this better internal consistency means the segmented image objects fit better with the actual surface features. A greater SDOM indicates greater separation between objects, which makes it easier to classify them. The purpose of classification is to separate the objects to achieve high consistence with actual surface features, meanwhile to classify the objects easily. So, the SDOM and the MOSD of objects' brightness can be selected as evaluation indicators to choose the best segmentation scale.

3. The experiment of optimal scale choice

3.1. Study area and data

In this experiment, the purpose is to extract the classification of urban surface features in Guangzhou Higher Education Mega Center (Fig. 1). Under the existing conditions, four data resources are used in this experiment: ASTER multi-spectral images (band 3,2,1) with a resolution of 15m, acquired in June 2007; SPOT multi-spectral images (band 3,2,1) with a resolution of 10m and 2.5m, acquired in December 2008;

QuickBird multi-spectral images (band 4,3,2) with a resolution of 0.6m, acquired in December 2006. The classification includes: Buildings, vegetations, waters and roads.

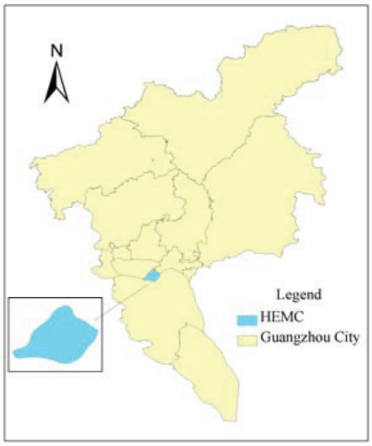

Fig. 1. Study area—Guangzhou Higher Education Mega Center (HEMC)

3.2. The choice of optimal segmentation scale

We use ENVI EX software to segment these 4 images under multi-scale, and scales were divided into: 10, 20, 30, 40, 50, 60, 70, and 80. According to the characteristics of each data resource, the merger thresholds for polygon is 87 (ASTER-15m), 88 (SPOT-10m), 94 (SPOT-2.5), 98 (QB-0.6m); then for all the segmentation scales, we calculate the SDOM and the MOSD of the objects' brightness (Table 1).

Table 1. The standard deviation of object brightness means and the mean of standard deviations

	ASTER(15m)		SPOT (10m)		SPOT (2.5m)		QB(0.6m)	
Scale	SDOM	MOSD	SDOM	MOSD	SDOM	MOSD	SDOM	MOSD
10	13.18	21.33	31.66	14.07	31.75	14.30	49.26	5.11
20	13.18	21.33	31.66	14.07	31.75	13.39	49.21	5.11
30	13.18	21.33	33.83	13.65	32.75	13.39	49.21	5.11
40	13.18	21.34	33.83	13.65	32.75	13.39	49.21	5.11
50	12.56	21.98	31.40	13.94	32.75	13.39	49.39	4.76
60	12.35	22.90	30.91	13.74	30.75	13.39	50.80	4.30
70	12.79	23.89	30.89	14.33	32.63	13.44	50.40	4.52
80	12.26	24.55	31.91	12.14	31.10	12.74	49.86	4.00

The changes of image information after scale segmentation could be displayed by evaluation index value varying with the scale clearly, X-axis represents segmentation scale, Y-axis represents evaluation index values. The figures show the SDOM and the MOSD of segmentation image objects of four resources with multi-scale (Fig. 2 and Fig. 3).

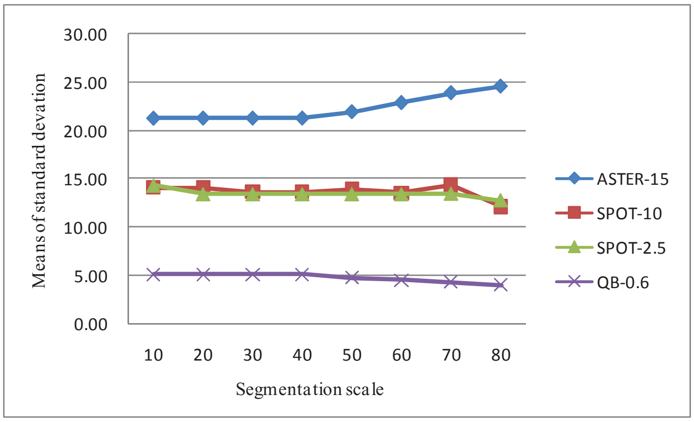

Fig. 2. The MOSD of objects' brightness in 4 data resources under multi-scale

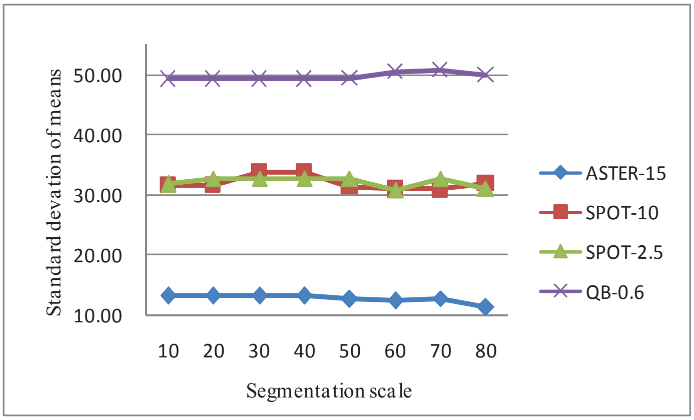

Fig. 3. The SDOM of objects' brightness in 4 data resources under the multi-scale

In classification and extraction of remote sensing image, the choice of image resolution and the choice of the optimal scale will directly affect the accuracy of information extracted. The more appropriate the scale is selected, the better image segmentation and higher extraction accuracy of the surface features we will get.

It is found from the experiment that, for the four data resources, when the partition size is 80, it can be seen with naked eyes that the extracted objects and the actual surface features extremely unmatch, roads and adjacent green space, buildings are hard to distinguish, SDOM and MOSD are abnormal, so herein after in the analysis, the scale of 80 is eliminated.

It can be seen from Table 1, Fig. 2 and Fig. 3 that, the maximum SDOM and the minimum MOSD of ASTER data are under scale of 10,20,30, while for SPOT with 10m spatial resolution data are 30 and 40, for SPOT with 2.5m spatial resolution data are 30,40 and 50, and for QB data is 60. The analysis shows that in extraction of various types of surface features, the optimal scale is not necessarily a single value, but usually a range of values. For a particular application, the optimal segmentation can be achieved within a certain range of segmentation scales. Fig. 4 shows the scale segmentations of four data resources under the best effect diagrams (part of study area).

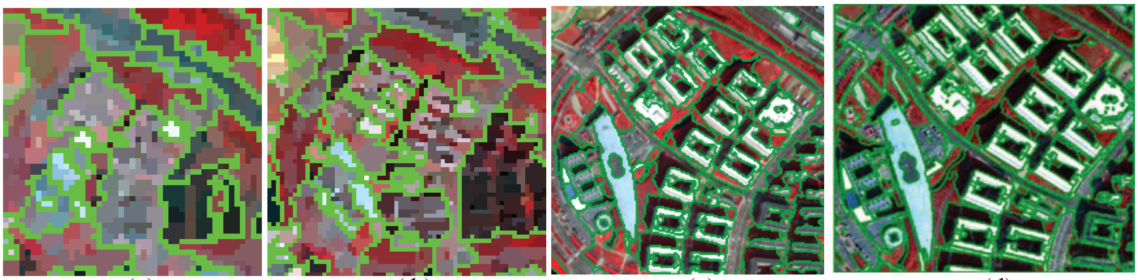

Fig. 4. Scale segmentation figures of 4 data resources under the best effect
(a) ASTER-15m; (b) SPOT-10m; (c) SPOT-2.5m; (d) QB-0.6m

3.3. The relation of segmentation scale and spatial resolution

It can be seen from above evaluation of 94scales and the best segmentation scale image (Fig. 4) that, the spatial resolution of images has a certain relationship with the scales: the higher the spatial resolution is, the greater the scale will be; the lower the spatial resolution is, the smaller the scale will be. It can also be seen that the higher the image resolution is, the better the effect of image segmentation will be; the lower the image resolution is, the worse the effect of image segmentation will be. Relatively speaking, ASTER image resolution is the lowest, so its scale is big, and segmentation effect is the worst; SPOT (2.5m) and QB images are with high resolution, so their scales are small, and segmentation effects are better.

3.4. Verify the result of optimal scale choice

In order to verify whether the results based on the MOSD and the SDOM are reasonable, we segmented the images of 4 resolutions according to the above scale (10, 20, 30, 40, 50, 60, 70 and 80), used the sampling method to divide the surface features in experimental area into four categories: buildings vegetations, waters and roads. According to the actual survey, we made one precise classification map for each resolution image as standard map to verify the accuracy, in order to avoid randomness of validation by sampling method. Fig. 5 reflects the relationships between overall

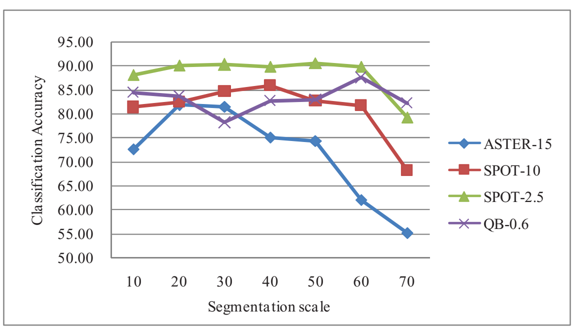

Fig. 5. The classification accuracy of 4 data resources under multi-scale

classification accuracy and resolution and scale. For ASTER data, the maximum classification accuracy is at 20 and 30, while for SPOT (10m) is at 40, for SPOT (2.5m) is at 50, and for QB is at 60. It can also be seen from Fig. 5 that the overall classification accuracy of SPOT (2.5m) is higher than QB (0.6m). Because of the high resolution of QB, the spectral heterogeneity increases within the same type of surface features, which decreases the separate between classes, and lowers classification accuracy.

4. Conclusion

By object-oriented method, this paper uses different segmentation scales to extract city surface features of images in four resolutions, forms image layers of different scales, analyzes changes of statistical characteristics and spatial characteristics to select the optimal segmentation scale, through evaluation of indicator changes following segmentation scale, the index of which are SDOM and MOSD of image objects' brightness. Actual verification shows that, the results from the optimal scale selected by evaluation index are consistent to actual surface features mostly. There are 4 remote sensing resources in this experiment, the best classification accuracy of which are classified by scale 20-50, expect QB. Besides, the classification accuracy decreases from SPOT (2.5m), SPOT (10m) to ASTER (15m), which shows that the classification accuracy is related to the spatial resolution. Generally, the greater the resolution is, the better the segmentation will be, but not the classification accuracy (such as QB image).

Acknowledgements

The corresponding author CHEN Jianfei gratefully acknowledges research grants from Natural Science Foundation of Guangdong Province (No. 9151051501000030) and from Department of Education of Guangzhou City (No. 08C026).

References

[1] Jia P, Li HT, Lin H. Research on Multi Source Remote Sensing Image Classification Based on SVM. Science of Surveying and Mapping 2008; **33**:21-3.

[2] Zhang J, Wang BS, Lv BQ. Study on Scale Effect of Object-Oriented High Spatial Resolution. Remote Sensing Image Information Extraction. Beijing Surveying and Mapping 2010; **1**:11-4.

[3] Zhao YS. *Remote Sensing Analysis Principles and Methods* .7ed. Beijing:Science Press. 2009.

[4] Wondcock C E, Strahler A H. The fact of scale in remote sensing. Remote Sensing of Environment 1987;311-32

[5] Wang QL. Study on Object-oriented Remote Sensing Image Classification and its Application-taking Urban Vegetation Extraction in Futian, Shenzhen city for example . Nanjing Forestry university 2008;22-4.

[6] Zhang J, Wang YJ, Li Y, Wang XF. An object-Oriented Optimal Scale Choice Method for High Spatial Resolution Remote Sensing Image. Science and Technology Review 2009; **27**:91-4.

[7] Lin XC, Li YS. Research on segmentation scale of multi-resources remotely sensed data in Chengdu plian. Science of Surveying and Mapping 2010; **35**:38-40.

[8] Huang HP. Scale issues in object-oriented image analysis. Institute of Remote Sensing Application 2003; 92-4.