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Research on A Segmentation Quality Evaluation Method of High Score Image Considering Area Difference

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Abstract

Aiming at the problem that segmentation quality in object - oriented image analysis (OBIA) can improve the accuracy of image information extraction. In this paper, the area difference index is used to evaluate the segmentation results of high score remote sensing images, and the AFI and FCSP evaluation indexes are used to calculate the segmentation quality to verify the reliability of the evaluation indexes in this paper. The research results show that the judgment results of the indicators in this paper are the same as the other two indicators, so the segmentation accuracy evaluation method of high score remote sensing images considering the area difference has certain use value.

Keywords

Area difference index; AFI; FCSP; Object oriented image analysis.

1. INTRODUCTION

Object oriented segmentation is a kind of image classification technology that is different from taking pixel as a unit, considering the spectral and spatial characteristics of ground objects, and composing homogeneous pixels with small spectral differences into objects of different sizes. Compared with pixel based image classification technology, this method can better consider texture, space, geometric features and other image information besides image spectral information [1], which has certain significance for high-precision classification of remote sensing images.

Object oriented image segmentation is the method and process of searching object regions with the same characteristics, and then obtaining regions of interest [2]. The quality of image segmentation has a significant impact on the accuracy of image classification [3], that is, the high-quality remote sensing image segmentation results are obtained, and the accuracy of remote sensing image information extraction is higher. Therefore, testing and optimizing remote sensing image segmentation algorithms and evaluating the quality of remote sensing images in order to obtain the optimal segmentation results have certain research significance [4]. For this reason, some experts and scholars have made some targeted research. Zhang Hua [5] and others studied the spectral and positional relationship between image reference objects and segmentation objects based on GF-1 images, constructed spectral similarity index and segmentation distance index to evaluate segmentation quality of object oriented segmentation results, and finally obtained the optimal segmentation parameters and improved image classification accuracy. Wang Hongsheng [6] and others constructed the unsupervised evaluation index of global optimal segmentation in order to obtain the optimal segmentation scale. The results show that this method reduces the subjectivity of determining the optimal segmentation scale. Liu Zhaoyi [7] and others improved and realized an automatic calculation model of global optimal scale, realized automatic acquisition of segmentation scale, and

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reduced the subjectivity of manual participation. Chen Yang [8] and others proposed a segmentation quality evaluation method of shape and position similarity, which can better obtain and determine the best segmentation parameters of images, and provides an effective method to improve the accuracy of image classification. Zhu Chengjie [9] and others proposed a two-way local optimal object matching method to solve the reference object matching problem in the supervision and evaluation method, which can better evaluate the segmentation results.

In recent years, with the emergence and application of domestic high resolution satellite, the research on the application of domestic high resolution remote sensing image in various fields has gradually risen. Compared with medium and low resolution remote sensing satellite images, high-resolution satellite images have more abundant texture and structure information [10]. When extracting information from high resolution remote sensing images, pixel based image information extraction technology is difficult to consider the image's strong texture features and geometric features. Therefore, it is of great significance to use object-oriented segmentation technology that can comprehensively utilize image information for information extraction of high-resolution remote sensing images. Zheng Lan [11] and others used the object-oriented classification method to classify the SPOT-5 image of Pingtan Island, Fujian, and achieved good results. Mao Zhaowu [12] and others used GeoEye-1 high resolution image to perform object-oriented segmentation and evaluate the segmentation quality, and obtained the best segmentation result, providing favorable help for later classification.

Based on previous studies, this paper proposes a segmentation quality evaluation method that takes into account the area difference, builds the linear relationship between the reference object and the segmentation object, evaluates the quality of the segmentation results, and provides an effective method to obtain the optimal segmentation parameters and further improve the accuracy of information extraction, aiming at the beneficial role of object-oriented segmentation results in improving the classification information extraction of remote sensing images.

2. EXPERIMENTAL METHODS

2.1. Area Difference Index

Use the high-resolution remote sensing image to obtain the boundary information of the object as the reference object for segmentation object comparison, set segmentation parameters to segment the experimental image to obtain the segmentation object of the object, analyze the difference between the segmentation object and the reference object, and evaluate the image segmentation quality according to the difference degree [13]. The smaller the difference between the reference object and the segmented object, the better the segmentation result and the higher the accuracy. Assuming that the reference object is P and the segmentation object is M, the segmentation quality evaluation index based on the difference of the intersection area between the reference object and the segmentation object is constructed according to the theoretical information:

$$MA = \frac{P_{area} \cap (\sum_{i=1}^{n} M_i)_{area}}{(\sum_{i=1}^{n} M_i)_{area}}, MA\epsilon(0,1]$$

In the above formula, MA represents the area difference index (Intersect Maximum Area), P_{area} Represents the area of the reference object, $(\sum_{i=1}^{n} M_i)_{area}$ Represents the merged area of split objects whose centroid location is within the range of the reference object.

2.2. AFI Evaluation Index

AFI index is proposed by foreign scholar Lucieer et al. [14] to select the segmentation object that intersects with the reference object and has the largest area among the segmentation

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objects participating in segmentation quality evaluation, and to construct a quantitative relationship compared with the reference object. The indicator expression is shown in the formula:

$$AFI = \frac{A_{ref_{object}} - A_{Max_{segment}}}{A_{ref_{object}}}, AFI \epsilon (-1,1)$$

In the above AFI $A_{ref_{object}}$ Represents the area of the reference object, $A_{Max_{segment}}$ Represents the area of the divided object. When the AFI index is close to 0, it means that the area difference between the selected segmentation object and the reference object is small, and the segmentation result is optimal. When there are objects intersected in the inverse ratio between the area of the reference object and the area of the object, the AFI index is the smallest, but the segmentation result is not optimal. Therefore, the index has some limitations in practical application.

2.3. FCSP Evaluation Index

FCSP (Figure of Correct Segmentation Percentage) is the percentage of correct segmentation. It refers to the segmentation quality evaluation index obtained by dividing a segmentation map into n pieces by area i, searching for the objects with the maximum correct segmentation area contained in the region, and then successively stacking and dividing by the total area of the segmentation map. Assume that the object of the maximum correct partition area in different area i is $S_i{}'$, and the partition area is S_i. Then the FCSP can be expressed as:

$$FCSP = \frac{\sum_i^N S_i{}'}{\sum_i^N S_i}, FCSP \epsilon (0,1]$$

This index is a segmentation quality evaluation index constructed by Chen Qiuxiao et al. [15] based on simple statistical calculation method after selecting the maximum correct segmentation object for the middle area of the segmentation map and cumulatively stacking and comparing the area of the segmentation map. The larger the index value, the better the segmentation quality.

3. RESULTS AND ANALYSIS

3.1. Study Area and Data

The data used in this paper is the GF-1PMS remote sensing image data located in Linzhou area, Anyang City, Henan Province. According to the research content, the densely distributed urban buildings in Linzhou City are randomly sampled to obtain the distribution map of housing buildings with research value for this study. As shown in Figure 1. The image includes blue, green and red bands, with a resolution of 1 meter. The main distributed objects in the image are houses, roads and green spaces.

Figure 1. Study area

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3.2. Image Segmentation

The image segmentation technology used in this paper is a rule-based object-oriented segmentation method provided by ENVI software, which includes three parameters: scale level, merge level, and texture kernel size. During image segmentation, the optimal segmentation parameters are obtained by repeatedly experimenting with parameter permutation and combination [16]. After many experiments, it is verified that the change of the merging threshold and the texture kernel threshold has little impact on the segmentation results. Therefore, the parameter combination used in this paper mainly sets the segmentation threshold, including 20, 30, 40, 50, 60. The merging threshold and the texture kernel are 90 and 3 respectively. The parameter settings are shown in Table 1. The reference object used in the experiment is obtained through visual interpretation as shown in Figure 2.

Table 1. Combination of segmentation parameters

Scale	Merge	Txture Kernal
20	**90**	**3**
30	**90**	**3**
40	**90**	**3**
50	**90**	**3**
60	**90**	**3**

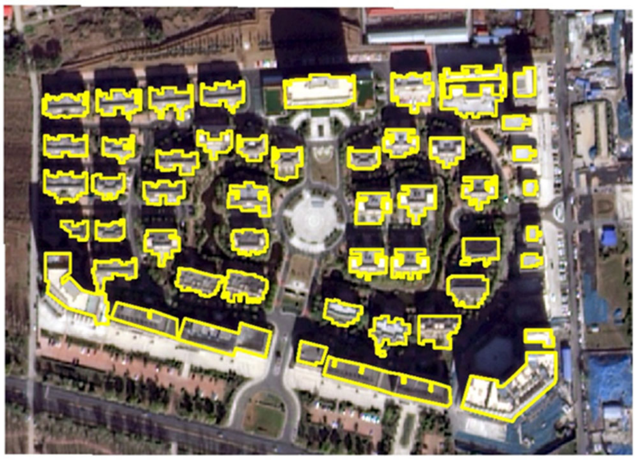

Figure 2. Vector boundary of reference object

3.3. Segmentation Results of Different Parameter Combinations

Randomly number each reference image, and select multiple merged segmentation objects corresponding to the reference object as validation samples. Combining the combination of parameter threshold setting and object-oriented segmentation algorithm, the experimental image used in this study is segmented object-oriented, and then the quality of segmentation results of different parameter combinations under the same image is analyzed based on the segmentation quality evaluation method proposed in this paper to estimate the area difference index. The results of each parameter segmentation are shown in Figure 3.

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Figure 3. Visual diagram of segmentation results of each parameter

In the figure, green represents the vector boundary of the reference object, and each filling surface represents the merging results of the randomly selected segmentation objects under different segmentation parameters. According to the segmentation results of each parameter, it can be seen that: under different segmentation parameters, each segmentation result basically tends to the reference image boundary; The coincidence degree between the segmentation results with different parameters and the reference object is small. Therefore, in order to better analyze the quality of segmentation results under different parameters, this paper constructs a segmentation quality evaluation index that takes into account the area difference, evaluates the quality of segmentation results under different parameters, and then selects the parameter combination with better segmentation results. The comparison table of index evaluation results is shown in Table 2.

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Table 2. Comparison of Index Evaluation Results

Serial No	Scale	Merge	Txture Kernal	MA
3	20	90	3	0.918
	30	90	3	0.962
	40	90	3	0.962
	50	90	3	0.951
	60	90	3	0.208
6	20	90	3	0.817
	30	90	3	0.817
	40	90	3	0.817
	50	90	3	0.817
	60	90	3	1.297
8	20	90	3	0.912
	30	90	3	0.912
	40	90	3	0.912
	50	90	3	0.912
	60	90	3	1.476
13	20	90	3	0.817
	30	90	3	0.969
	40	90	3	0.485
	50	90	3	0.485
	60	90	3	0.975
14	20	90	3	0.972
	30	90	3	0.972
	40	90	3	0.972
	50	90	3	0.972
	60	90	3	0.978
15	20	90	3	0.887
	30	90	3	0.919
	40	90	3	0.866
	50	90	3	0.866
	60	90	3	0.937
16	20	90	3	0.026
	30	90	3	0.849
	40	90	3	0.953
	50	90	3	0.905
	60	90	3	1.002
17	20	90	3	0.923
	30	90	3	0.923
	40	90	3	0.923
	50	90	3	0.898
	60	90	3	0.864
19	20	90	3	0.917
	30	90	3	0.939
	40	90	3	0.812
	50	90	3	0.874
	60	90	3	0.837
22	20	90	3	0.023
	30	90	3	0.894
	40	90	3	0.894
	50	90	3	0.863
	60	90	3	0.863

According to the calculation results of area difference indicators under different parameters corresponding to each sample, it can be seen that:. (2) According to the change trend of parameter combination under each segmented sample, when the segmentation threshold is 60, the proportion of samples is 60%. Therefore, according to the segmentation quality evaluation index constructed in this paper, when the parameter combination is 60, 90, and 3, better segmentation results can be obtained.

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3.4. Evaluation of Different Indicators Based on Segmentation Results

In order to verify the reliability of the segmentation quality evaluation index constructed in this paper, AFI and FCSP are selected to evaluate the experimental image segmentation results under different parameter combinations, and the optimal segmentation parameter selection results of different indexes are obtained and compared. Table 3 shows the results of calculating the mean values of different indicators of the segmented objects under the corresponding numbers of the reference objects.

Table 3. Calculation Results of Different Parameter Indexes

Scale	MA	AFI	FCSP
20	**0.661**	**0.501**	**0.430**
30	**0.877**	**0.489**	**0.462**
40	**0.889**	**0.489**	**0.465**
50	**0.871**	**0.471**	**0.488**
60	**1.033**	**0.446**	**0.522**

According to the average value of different indicators of the segmentation object, combined with the evaluation theory of each indicator, it can be seen that: (1) The larger the MA is, the closer it is to 1; The smaller the AFI value is; The higher the FCSP value, the better the segmentation quality. (2) The optimal segmentation parameters selected for AFI and FCSP indicators are consistent with the results of the selection of indicators considering area differences constructed in this paper, that is, when Scale=60, Merge=90, and Txture Kernel=3, the segmentation quality is the best.

4. CONCLUSION

The segmentation quality evaluation index constructed in this paper considers the intersection area difference between the reference object and the segmentation object. By randomly selecting the segmentation object and calculating the evaluation value of the index under different parameters, the parameter combination: 60, 90, 3 are the best segmentation parameter combination. At the same time, AFI and FCSP indicators are selected to verify the reliability of the index in this paper. The results show that the optimal combination of segmentation parameters selected by the three indicators is consistent, that is, when the parameter combination is Scale=60, Merge=90, and Txture Kernel=3, the segmentation quality is the best. Therefore, this index provides a reliable index for high score image segmentation to obtain the optimal segmentation parameters.

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