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Heterogeneity Measure Based Segmentation performance

Evaluation for Remote Sensing Image

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Abstract: In order to evaluate segmentation quality of high resolution remote sensing image, an un-supervised segmentatio N Evaluation method based on heterogeneity measure was proposed. Firstly, global variance and Weighted Moran index were introduced to express the Intro-object and Inter-object Heterogenei Ty. Then The two heterogeneity measure were normalized and summed to evaluate the whole of performance. Secondly, to evaluate the local quality of image objects, a heterogeneity measure based on object variance and local Gear Y index was presented. Finally, an experiment is carried out on a remote sensing which was segmented by Multi-esolution segmentation method. and heterogeneity measure proposed in this paper is used to evaluate the segmentation result. It shows that the heterogeneity measure can effectively evaluate the different scale segmentation results and meanwhile C An identify regions which are over-segmented or under-segmented.

Keywords: Remote sensing image; segmentation evaluation; scale; Moran index; Geary Index

with high-resolution remote sensing data , Object-oriented image analysis (obia) The method is widely used with the "^".] obia square First step is image segmentation ,for generating image objects , as basic units for subsequent analysis processing . Because of the size differences in remote sensing images are large, , Multiple-scale objects in the same scene , using a single metric in the split process easy to create a split and a less split phenomenon [3]. over split causes homogeneous areas to be divided into multiple different objects . characteristics of the , object when the split is serious description accuracy Drop . and the due split will be in the same image object contains multiple object categories , makes it difficult for an object to be accurately recognized as a a feature . the choice of the partition scale is challenging in the field of remote sensing Research topic , Its difficulty is in , No before splitting

The method determines what parameters can produce a satisfactory split result . so , in remote sensing image segmentation process , How to determine and select a point metric critical .

Image Segmentation evaluation methods can be divided into artificial evaluation side method , Supervision evaluation method and unsupervised evaluation method [4] . artificial comment Price Method Unable to implement evaluation automation , Monitoring evaluation methods according to Lai ground Truth-map Precision , getting difficulties with the truth-graph , Time consuming , cannot be applied to the scale selection in the split procedure . unsupervised methods Evaluate different segmentation results based on a quality guideline and to sort , compare different scale split results , Advantage is not required to Truth . in

the obia method , Non-supervised evaluation quality guideline [5] is an image object that should have

a (Internal) consistency and (to outside) diff , Here on the basis of the guidelines for unsupervised Split evaluation method .

The current typical unsupervised evaluation method can be based on the quality of the is divided into two categories : Object-based heterogeneity method , includes local Variance Method [6], Local Variance rate Method [7] , and so on ; object-based methods for consistency and heterogeneity between objects in [3 ,], and vs. previous category Methods Consider space dependencies between objects , more consistent with Quality guideline . on the basis of existing research , Here is a Segmentation evaluation method based on heterogeneity measures . This method is divided into two steps , First Take advantage of global variance and global weighting Moran Index Table Global heterogeneity of the image , and as an integral part of the image price measure ; The second step proposes a method based on object variance and partial Geary Index Image Object Segmentation evaluation measures , To determine the image Local existence or lack of partition . Take advantage of the first step to make The global optimal scaling result ; The second step is the global ruler on the basis of , get locally segmented and less-split objects . This method evaluates the overall split effect ,You can also Evaluate the split result of the object .

1. Global Heterogeneity Segmentation Scale evaluation Method

Documentation [9] indicates that , in 0 BIA Profiling methods , at the bottom up image segmentation should not contain Top-down features Experiential knowledge ,therefore unsupervised split evaluation should have two Features :

1) The image characteristics of the evaluation method should be the image's low -level feature set , such as basic spectral strength characteristics ;

2) Evaluation of features should take into account the spatial distribution of objects Department , and evaluates between adjacent objects .

Is based on the above two features , to design the global pair for the split result like consistency uses internal heterogeneity of objects , all A weighted sum of the variance of the object means , if ^ is the first I to like variance ,a , is its area , The Global object consistency refers to number VI on

K

VI = name T. ~ (1)

where , is the total area of the image ; k total for the split object number . VI smaller , Indicates that the overall object internal consistency is better .

heterogeneity measures between objects are commonly used Moran space autocorrelation factor [1 0], It reflects the overall spatial correlation of elements in a datasetsex . global Moran Index calculation formula is

Kk

KH (y,, -y) i JJ -y)

MIg two ^=----------(2)

X (y.) - y)2 (X X w All (*) (+) J)

^ =1 for

where , . The represents the spectral mean value of an object ; J represents the spectrum of an entire image mean ; Wj represents the spatial adjacency of an object , two objects adjacent for 1, not adjacent to 0 .

calculates the global Moran exponent , (2) treats equally Some image objects , cross- section areas generally have a large area than Small Image object , The difference between these image objects will affect the number significantly, ; and its adjacent The difference between the connection objects is often less than obvious . for thisconsider Dimension factors for objects , to propose a weighted Moran Point number wMI, is represented as

K2 X ir X wJ [] [* * *] ( ) (y. - y()(y ,-j)

WMI =^----------. (3)

X (y.) -y) 2 (XX ["] w J)

Global Moran The exponent indicates that the object's average value is adjacent to the as mean difference , Lower index value , The describes the object's space phase off Lower , The statistical variability of the adjacency is stronger , split effect

Better .

A good split should have the image object have a lower pair of like inside variance (Lower object heterogeneity), and a lower pair like between Moran index (higher heterogeneity between objects), split knot The global heterogeneity measure of the fruit evaluation needs to combine the two to make the with . to make an object heterogeneity measure and object heterogeneity test degrees equal play function , Adoption (4) on both process .

NVI = (VI) - VI _) /(VI - - VI _) ; nwmi = (wMI - wMI_) /(wMI_ - WMI _).

(4)where , VI _ , VI _ , WMI _ and WMI _ is divided by different scales The maximum and minimum values for the cut results are . normalized ,, can be to split global heterogeneity evaluation measure :

GH = nVI + nwmi . (5)

The smaller the global heterogeneity measure , The explains the better the segmentation results .

2. Local Heterogeneity scale evaluation method

1 Global heterogeneity evaluation indicators in the section take GH Minimum value Gets the global optimal scale . but with a single scale split still cause partial area over or under split , requires a local Heterogeneity evaluation method to evaluate for each image object , and then to implement a local split scale correction .

Documentation [3] takes a local Moran the exponent to determine the of the object Local heterogeneity . in the Moran Index, the entire image is used spectral mean value of , over split object on spectral mean range area , Low index value , cause inaccurate judgment . for this , take Geary refers to the number to calculate the local space autocorrelation of an object . local Geary Index calculated as

LGI I = . 1-y -) • (6)

Geary The calculation of the exponent considers only the between adjacent objects diff , and Moran index opposite , local Geary refers to the value morebig , The object is less relevant to its neighboring objects , Local heterogeneity stronger . When judging the local split effect of an Image object , , need toobject heterogeneity measure and object heterogeneity measure combined to . The heterogeneity of the object takes the variance of the object v represents, Objects heterogeneity with local Geary index LGI represents A . takes the local heterogeneity measures should be able to differentiate between split and less-split phenomena . for this , First offset difference and local Geary index to normalized Process , getting expression :

= (v - v mm) /(with legs - 0 ;

\nlgi = 1 - (LGI - - LGImJ /(LGL - - LGImJ •

(7)in 1 minus LGI normalized value of , can make the NLGI Local heterogeneity trends and spatial correlations between objects are positive than , also value smaller , The lower the spatial dependencies , heterogeneity between objects Better . use formula (7) define local heterogeneity of objects measure to

LH = (NV - NLGI) /(NV + nLGI) . (8)

LH The range of is [-1,]. When the value is close to 1 Table clear Image objects with large variance and smaller space correlation sex , There may be an under split phenomenon ; Conversely , When the value is close to - 1 , There may be a split phenomenon .

3. Experiment and Analysis

3.1 Experiment Procedure

experimental data is U.S. San Diego neighborhood , Resolution is 0 • 3 [] / Pixel , by Red , Green , Blue 3 bands make up , The real that the intercepts field size to pixels XThe Pixel , As shown in figure 1 shows .

diagram 1 experimental Image

to investigate the proposed segmentation evaluation method , use multiresolution split MS(multiresolution segmentation) method [211]

to split the image . set shape weights 0. 2 , Compact Weight 0. 5, split process takes different scaling parameters , and then use the The heterogeneity measures are evaluated for each scale segmentation result , Select The optimal scale . on the basis of the optimal scale , through local heterogeneity measure for each Image object , by setting thresholds , get split and less-split area , and then you can for amendments . The experiment process is as follows: 2 ,.

3.2 Results and Analysis

uses the MS in the process of splitting , First in pixels of the image Execute algorithm , adopted scale parameter 5 . then , use more Resolution Segmentation hierarchy features , at low-scale images object based on , Increase scaling parameter , gets a higher-scale partition results . analysis from the scale ten start , scale by 1 Step increase , to end , generate 291 partition Results . on This base Foundation , Use the proposed heterogeneity measure for each split result calculation , The results in a map of the diagram 3 as shown .

0 1 ⑻ 0

scale scale

(a) global Moran index (b) weighted global Moran exponent

(c) Global Variance (d) Global heterogeneity measure

diagram 3 heterogeneity measures vary with the partition scale

from Diagram 3 (c) to see , When the partition scale increases , all local variance increase . This is because the image object size increases , will package include more feature details , result in increased heterogeneity in objects ; from Diagram 3 (a) and Diagram 3 (b) Know , Moran The index increases with the scale The potential is reduced by . proposed weighting Moran Index due to consideration of object area effects , when object area increases , curves are easy to produce Live fluctuation . increases with partition size , Severe due-to split Mix different objects , on subsequent classification no longer make sense , so , in diagram 3(D) ,, Show only beforeGlobal heterogeneity of the scale cloth . based on weighted Moran Index global heterogeneity measure in ruler to % min value 0.836 6 , corresponds to NVI = 0.357 7,nwmi = 0. 478 9, get 345 object ; and based on Moran Global heterogeneity of the index when the scale gets The minimum value .

with a weighted Moran index due to reduced small area image object effects , vs. global Moran index compared to, Select Best partition scale , Chart 4 is the best scale for two indices the split result chart . There are split and less-split phenomena in diagrams , Because of the over split of the large homogeneous area , owed nowThe image has a greater impact on classification accuracy , The weighted proposed by Moran The exponential global heterogeneity measure is more inclined to give the segmentation better evaluation .

(a) scale and local magnification map

(b) scale and local magnification map

diagram 4 Optimal scale split results

In the process of judging over and under segmentation , because it cannot determines which thresholds and split scales can produce good results , this to set the object's local heterogeneity value before and after 10% as cross-split and less-split thresholds , Scaling optimization . diagram 5 to 345 Local heterogeneity

measure distribution statistics straight side Figure ; Chart 6 For the segmented area and the less-segmented that are worth the threshold

Area , you can see from the diagram that , over-split is mainly concentrated in spectral strong degree Even areas , the Due-division exists mainly in some mixed objects 's Area .

4. closing

feature values and graphs for image objects with different partition scales The has an effect on the results of the classification , Here's the split evaluation party compared to traditional segmentation evaluation methods , more focused on split knot Fruit Scale evaluation , No other segmentation evaluation criteria considered , such as edge description accuracy . The split evaluation method proposed by can be added to the with other split evaluation methods . addition , using lift out of the method to get the image of the segmentation and the less-divided area , Subsequent corrections in favor of these areas , such as excessive cut area can merges into larger-scale split objects ,The owes the partition area to take a smaller scaling parameter to split . at the same time , exploit proposed The method can select a scale for the same split method break ,can also generate the same number of objects for different split methods Comparison of under conditions of .

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