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A method for Road detection from high resolution

Color Remote Sensing Image

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Abstract: In this paper, a road extracting to proposed by combining FLD feature extraction and shape feature. This method has four main steps. Firstly, the color information of labeled the samples is extracted. Then, Fisher linear discriminant is used to implement feature classification to segment the images into two Categories:ro AD and Non-road, according to the information extracted before. After that, the initial road network is extracted by threshold segmentation to the result of according. Finally, the Road shape optimization features and morphological processing are used to remove erroneous extraction and op Timize the extraction results. Experiment results show this proposed method can realize the main road extraction from the remote sensing image with C Olor information.

Keywords: Fisher linear discriminant; colors category; Shape feature; Threshold segmentation; Road Detection

The rapid development of remote sensing technology has driven the remote sensing image space to be divided into Quick Increase in resolution , High resolution images in remote sensing applications data sources for a large proportion , greatly facilitate target detection , GIS Data Update , Research on digital mapping and automationm . city planning , traffic control , automatic vehicle navigation , Geographic Information Department database updates are all dependent on the High-precision automatic identification of the road and Detecting and real-time updating of road network information , Road information in The status of urban economic activities is becoming more and more high .

near For years , Many scholars in remote sensing image Road extraction The has done a lot of research . , The proposed algorithm is mainly based on Line features , facial features and line-surface binding methods , like Snakes methods , Dynamic Planning method , template matching , Horizontal line method, and Hough transform , Object-oriented method ,, mathematical morphology square , Law , Image Segmentation method , The method of shape feature detection and the Knowledge based

method of recognition ^. dish 3 etc [2 the proposes a method of threshold segmentation and morphological combination of road extraction , first uses the threshold scorecut to process the image into a two-value image containing road and non-road ; reuse morphology to remove noise ; last used the shape of the road special sign the final road network . This method does not require a human to give a seed Point and Road initial direction , improves road checks to some extent measure Automation level ; But this method extracts the result to the threshold of large A small and structural element selection depends too large . Xu etc 0 Use points Water

Ridge Double threshold segmentation Algorithm extraction path , First use split water Ridge double

threshold segmentation algorithm get the initial outline of the road ; Then with Multiple weighting method to get the exact edge of the road , morphology is used for Remove noise and refinement finally remove non-road with shape features area . This method is simpler for objects , less intrusive images checks well , but bad for complex image detection and

with a too simple Shape feature index , cannot detect shadowed covered roads . Abraham etc [4 Using a wavelet based watershed segmentation combined with fuzzy inference system detection Road letter rest ; Xu Rui S departs from the gradient diagram of the image , Homogeneous Remote sensing Shadow like , Remove noise by Shape feature , Highlight Road information , last filtering Road seed points with perceptual organization constraint operators , connected into road network . Two methods for road extraction in urban areas better But rural sense is not effective . . Miao etc [6 detecting roads with spectral and shape features , requires too

many manual intervene , and detected a broken or missing path .

chroma based on image color information , for saturation and brightness different , proposed FLD the feature extraction category of determines the thresholds for the split , the Auxiliary Shape feature index detects the path . Experiment table Ming , This method resolves the classification dependency characteristics in several of these methods single _, threshold Segmentation Difficulty Large , shape feature not fully exploited and not detect problems with crooked roads , for better detection effect true Broader road detection method .

1. Key Technologies

1.1 FLD linear discriminant

Fisher linear discriminant (Fish er linear discriminant) also is called a linear discriminant analysis (linear discriminant analy - SiS), A linear set of that was first used in statistics to look for features close . The combined variable can be used as the basis for the category , and can also be used with down-Dimension processing for datasets , preparing for further categorization . This algorithm is belhumeur on 1996 Year Introduction pattern recognition and AI domain , has become the classic algorithm for pattern recognition . Fisher the basic idea of a linear discriminant is to use a high-dimensional pattern-like This project to the best discriminant vector space , to extract a category letter The effect of the dimension of the compressed feature space , Post-projection guaranteed mode Samples have the largest inter-class distance and minimum class in new subspacesinner distance . as a _ A valid feature extraction method , It can make the class scatter matrix of the projected pattern sample maximum , at the same time class scatter matrices minimum .

The rationale for the algorithm is : the looks for a high dimensional data drop to one-dimensional values for linear functions , then N Dimension Data project onto a straight line , marked ®

J = WT [] () X . (1)

where : W is the projection vector ; X is by _ The data in the pound dimension is composed of Data Set .

Consider a set of extended space data with C class , is W 1, , ..., W C ; X = 0^,2,... ,M) Every artful in is for N Dimension Data and attribute to class %. where :/=1, 2,...,C; J = 1,2,..., M . to define the total class scatter matrix to

C

SW = X [] [] () PiS >- (2)

1= 1

where : » / M , is in M A total sample can be attributed to W , Sample number of class .

Define the scatter matrix within each class as

N

S / = X (x -M/ /) (x -M/) T. (3)

I =1

where ... is W / the mean value of all samples in the class , that is

fi / = - X , / = 1,2,3, [• ..., C . (4)

N/

where x is class W / Sample in .

The class scatter matrix that defines the sample is

C

Sr = X [] [] () p/^l /~ 1 / _ 1) T' ' (5)

where / L is the mean value of all samples , that is

1 M

m = MXxJ . (6)

assumes Sw is a nonsingular matrix , you want the class to be after projection Greater divergence is better , simultaneous class internal discretization is better , definitionFisher Linear decision benchmark function is

WT sr w

J (W) = Arg Max - t--. (7)

WTSWW

To want Fisher determines the best effect , requires J (W) The corresponding eigenvector when the maximum value is obtained , The can be mathematically converted toto arrive at ,W the is the solution that satisfies the following equation 0 :

Sr W/ = A/Sww / . (8)

(8) The key to the solution for is Sw 1 to exist . if Sw non-singular , is the Sw _1 Sr The characteristics of the problem , (8) to transform to

Sw " 1 SRS W/ = A/[] /. (9)

and then solve the with the eigenvalue ; if Sw 1 does not exist , is no solution .

For Fisher The linear discriminant principle is : To base an image on the a feature that uses the Fisher linear discriminant into road and non-road Two categories . can look ,each pixel value as a , GB values three-dimensional line vectors with x The represents . assumption Ji, 2 are already available the set of road and non-road two types of pixels,/ Medium all have n/ Sample (/=1,2). make & and H easier to subdivide if the distance between two classes is as large as possible , the class has discrete degrees can be small . The probability of the two classes appearing coincident is minimal , will discriminant the function transforms to favor pixel calculations in the form of

JW = (m1) - m2) V (s 12 + s 2 2) •

where : m / and s 2 (/ = 1,2) is the first / all pixels of the class mean and variance (class dispersion), is defined as :

m / = - X x , /= 1,2 (one)

n / Xey .

x E J.

1.2 shape feature recognition

After using threshold segmentation to detect a preliminary road network , still exists confusing false points in road and non-road features , Road and The main differences between other features _ are shape features , Road Main to behave linearly slender features . based on obia (Object Based on Image Analysis) The main use of the area shape in the feature includes aspect ratio r , Rectangular degree R and roundness C . where ,r Suitable for linear road detection ,R fit curves Road Check test , Reference document 5-] introduce 3 Shape Index to isolate the road and non-road features .

1) compact /= 4nS/ P2. where :S to area area ; P is a zone perimeter . / is scoped to . </ no 1, Larger ,, The area is closer to the Circle .

2) fine length r = a /b is the aspect ratio of the region outer rectangle , a and b The long edge length and short edge length of the area, respectively, are .

3) Rectangle degree R =S /Srect (), Represents the area of a zone and its minimum - External Rectangle area ratio , The used to measure an area and a rectangle similarity ,Important for identifying regional main roads . size from 0 ~ 1 , the greater the value indicates the closer the region is to the rectangle .

color Feature extraction

compared to other visual features , The color feature is not caused by the image Dimensions , changes in direction or angle of view changed significantly . Greaterstability and ease of detection benefits than get a lot of learning The favor of the and its in-depth research , now plays An important role in feature detection technology 112 .

uses the HSI color space is greater than RGB System closer to people The advantages of visual habits and color perception , convert image to this space for feature detection . based on the tag's sample , respectively Extract sample images on HSI space chroma , saturation and brightness message as Fisher discriminant classification based on .

the uses geometric derivation from RGB Color space is HSI

2. Experimental results and analysis

2.1 Experiment Results

Select two different resolutions , different regions , Different object classes Remote Sensing Images experiment , to verify that the proposed algorithm is in variousrobustness under different conditions .

Data 1 is a region with a resolution of 0.61 m Multi-light for Spectrum Quick^Bird image , image size 2 00. pixel X2 002 pixels „ as shown 2 shows . This image is an urban image , Road detection The main interference of the is the spectral characteristics of similar buildings and spaces , stop yard wait . data 2 for a region of Shanghai Quick^BirdMulti-light spectral image , resolution is 4 m. Primary interference to the road is field , a village of vegetation and small buildings .

2.1.1 Feature extraction classification

reads the original image , Click somewhere in the image manually , implements sample mining set , sample number is discretionary , but minimum 2 , take note is sample collected _ to be valid , is road and non-path places are collected ; and then use the style ~ test sample differs from HSI color space H S and / Letter „ at this time a sample ofH S and / Can be viewed as a three Dimension Data ; and then read the data as a dataset , calls FLD single-Class categorizer for (FLD The class classification program is based on its original Council first implement) calculate projection vector W . Large number of experiment tables Ming , This step has a certain versatility . If two images have a colorcolor close , , This step can omit , Direct next .

2.1.2 Preliminary detection of the road network

Extract classification by feature , calculates the Fisher voted shadow direction vector W= 0.132 1;0.698 8;-0.703 0], heavy New Read entire image , converts each pixel of the image in this direction projection category (due to more image data , for each pixel HS

and / cannot here ----- lists) . according to Fisher Classification of Knots

to determine thresholds for segmentation , Is provided by the type to determine that this experiment is the most

2.1.3 Road recognition based on shape characteristics

from Diagram 3 to see , Initial detection of a threshold segmentation Road network still has a lot of spots , under 1.2 section 3 a shape special The is indexed to go unless the road spots are marked . references 5-] and large Volume experiment the most appropriate , have _ the conformal shape identifiers are as follows : When the dot is tightened /<0 5 As the word road network , to keep , Delete orphaned spots ; when dot tightening

/>0.5 deletes directly ; Compact /<0.5 and thin length R <4 and rectangle and >0.4 when , may consider non-road information given delete With the exception of . finally uses morphological corrosion , expansion for burr removal , break point connection , get final test result , As shown in figure 4 shows .

2.1.4 experiment 2 detection results

Experiment 2 The image is provided by the type The optimal threshold calculated by IS (75,0,0),; Experimental results are shown in Figure 5 shows .

is known from the final detection results of two experiments , algorithm for buildings with similar spectra , parking area images main track high detection rate , detected road clear , Smoother ; to have fields , There are some rural images that interfere with vegetation and small buildings. better detection effect ; can also have a curved path with a certain radian efficiently detect .

2.2 compared to traditional method effects

to compare the effects of the proposed and traditional methods , logarithm accordingto 1 and data 2 with a traditional Hough transform M and sub- Water Ridge threshold segmentation Combining shape features M to process , detect effects as shown 6 show .

The detects the effect of both methods and the method detected by the effects are carefully compared to find : Direct Hough Transform detection , line detection is better , but cannot detect bend roads , Check results more spots and detected roads have break conditions ; and the method used to detect a curved road is good ,

spots and fewer break points in the road . based on a watershed threshold score cut combined with shape features for road detection better than Hough method of Transformation , can detect curved paths , detected details More but has a false detection phenomenon ; and the method presented does not have an error detect phenomenon . See , The detection method is better than the previous two species , concrete Good robustness .

3. Conclusion

The Classic algorithm in pattern recognition FLD introduce remote sensing shadow like road detection , Extract sample images in HSI a letter for the color space ,, usingFisher feature classification divides images into road and non-road Road Two categories ; and then start the threshold segmentation detection on the basis of classificationStep road network , then combine shape features to detect road network ; finally filling holes and breaks with morphology ,, remove burrs, and so on The detected road network is optimized . The experiment shows that , the method to The straight and curved trunk of a color image has a good effect. , Nathan A few ways to fix a limit on curve road detection , by Fisher discriminant Best threshold segmentation effect more thresholds split , improving accuracy , with a reduction in threshold determination ofworkload . But the following are not sufficient .

First , cannot detect both main and small roads at the same time , If the threshold the size of the value is set to detect small paths at the same time as the main trunk line Road , detects too much noise , Some noise in subsequent processing cannot go to except , affect test results , How to make small roads and trunk paths all Detection is the focus of further research .

Second , Extract color information to categorize , color difference is greater images require a new feature extraction , more hassle ; and Smoke takes fewer features , Easy to put and road this _ features close to object detection , Increase workload for subsequent processing , and Hue inconsistent or multiple shades of road image detection effect of the want . workaround for multiple feature extraction , How to make multiple feature extraction category , Improve the accuracy of initial road network detection also is the focus of the next study .

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