# ROAD EXTRACTION FROM HIGH RESOLUTION REMOTE SENSING IMAGE BASED ON MATHEMATICS MORPHOLOGY AND SEED GROWTH

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**ABSTRACT:** Extracting the targets information from the remote sensing image has become the important method of updating the spatial geography information. With the development of spatial technology, sensor technology,digital image processing technology and the computer pattern recognition technology, how to extracting the targets information from the high resolution remote sensing image has become the important research content of the spatial information renews. And the exhaustive and accurate road net information plays an important role in the traffic control, the urban planning, the automatic vehicles navigation, the emergency business processes and so on. The Quick bird high resolution remote sensing image of Shenyang which is obtained in September,2006 is used as the research data. First, carry on pre-treatment to the remote sensing image, mainly uses the colour transformation-hsv transformation; Second use the supervised classification method– Support Vector Machine to classify, and evaluate the precision of the classification result, then change the classification image into binary image, and use the mathematics morphology method-(open\close operation)simplification image data, to maintain their basic shape characteristic, and except the irrelevant structure characteristic, in this paper we select the structure elements se0=strel('line',10,30) and se1=strel('line',10,120) shape operation to the binary image, extract the road skeleton; at last use the seed growth algorithm to extraction the road median line that has certain length and direction. the experiment proves that This method that gives priority to mathematics morphology and gives assistance to the seed growing method has extract the road net information well, specially has the superiority in extracting the road detail information.

## 1. INTRODUCT

### 1.1 Perface

As the important information source of digital photographic survey, feature extraction from the aerial image is the international development front topic of photographic survey, the remote sensing and the computer vision has the extremely important theory and the practical significance. With the development of spatial technology, the sensor technology and the computer technology, how to clear extract the targets information from the high resolution remote sensing image has become the important research content of the spatial information renewal. During the information time, how to automatic process, cognition and interpretation magnanimous image data is the important question during the entire social information process. The urban road is taken as the city skeleton, hand the pivotal status without doubt in the economic activity in the city. The high accuracy, the prompt renewal road net information plays an important role in the traffic control, the urban planning, the automatic vehicles navigation, the emergency business processes and so on [1].however, as we extract road information from high resolution remote sensing image ,the road width broadens and receives more serious disturbance, which increases the difficulty of extracting information.

### 1.2 The research present situation

Domestic and foreign has already many research of road extraction also has made very many achievements. And the correlation scholars have carried on the summary regarding this[2][3][4]. Jeong-Hun Jang et al[.5] .first extract the center line of the straight-line band , then detect the different types of straight line band in this foundation , through the method of distance transformand so on ;Donald and Bruno[6] have thoroughly discussed road recognition method of 10 meters resolution satellite image in the multitudinous research foundation; Gruen and Li [7]has used the GIS data to extract the linear features from the digital picture ;Zhang, C.， Baltsavias, E [8] extract road network information from high resolution Aerial image based on Mathematical Morphology; Teger, Mayer and Radig[9] extract road network using class and fuzzy class;Tupin,et al.[10],.extract road features from SAR images: using random field model; Katartzis,et al.[11] ,first use the soft mathematics morphology method to extract all road sections, then carry on liking the median line of the road section using the Markov Random Field Model , at last obtain the road net; Chanussot[12] detects linear object in SAR image using fuzzy fusion technology;Yuille and Coughlan[13] analyzed and research the method of the automatic road features using probability methods,such as Bayesian,max-min-estimation ,the condition distributed and so on,through establishing structure tree; Laptev,et al.[14]research semi-automatic Linear Feature Extraction by dynamic Programming and LSB-Snakes from aerial image;Hu,et al.[15]research semi-automated road extraction from aerial image based on Remote Sensing, template match and neural network;Shi Wenzhong,et al.[17]extract road network by the method that straight line matching combines with Mathematical Morphology post-processing.But, at present, the researches of the road features extraction mainly aim at the aerial image and low, median resolution satellite remote sensing image (resolution is lower than 10 meters),the researches of the high resolution remote sensing image are few.

### 1.3 The situation of the research area and the experiment process

The quick bird high resolution remote sensing image of Shenyang which is obtained in September, 2006 is used as the research data(see Figure 1),In this paper, the software ENVI and Matlab Basic Mentality is used. First, we make a pre-treatment to the remote sensing image; Second we use the supervised classification method– Support Vector Machine to classify the remote sensing image, convert the classified image into binary image; then we use the mathematics morphology method to simplify the image data, maintain their basic shape characteristics, and except the irrelevant structure characteristic, the tiny branch and the noise, extract the road skeleton; at last we use the seed growing algorithm method to extract the road median line of certain length and direction, and overlay it with the original image to assess precision

Figure 1 The original image

## 2. EXPERIMENTAL RESEARCH OF ROAD EXTRACTION

This method mainly includes the following several steps: The image pretreatment; use the Support Vector Machine segmentation method to obtain binary image; process the binary image by mathematics morphology method, obtain the skeleton image; through limiting the length and the direction to reject the tiny branch using seed growth to obtain the final road median line; finally superpose the road median line with the original image to assess precision.

### 2.1 Image Pretreating

The mainly work of the Image pretreatment is image enhancement, deleting cloud and mist noise, the aim is to wipe off irrelevance noise, enhance image quality, stand out the need information ,which is advantageous to interpretation and further processes. there are many image enhancement methods, such as spatial filter, color transform ,image operation, multi-spectrum change and so on .But the concrete method must meet the concrete experiment image data need. the image in this paper hasn't cloud and mist, is carried on color transform, according to the experiment.

### 2.2 Image Clustering Segmentation based on Support Vector Machine

The Support Vector Machine classification (Support Vector Machine is SVM) is one kind of machine learning method that is establishment in the foundation of the statistical study theory(Statistical Learning Theory or SLT) , with the aid of the optimization method to solve machine learning question, its main thought aims at two classification questions, seeks a optimization classification in the hyper plane which is token as the classified plane to guarantee the smallest classification error[ 18 ]. This method suits the limited sample (small sample) question, has solved the problems existing in the traditional method(such as neural net) in the great degree , like model choice, study on-linearity, multi-dimensional question, partial minimum point question and so on. The biggest different between the Support Vector Machine(SVM) and the traditional statistical pattern is that the Support Vector Machine cannot cause the Hughes phenomenon (Hughes phenomenon) - to the limited training sample along with the characteristic dimension increases the classification precision reduces, and when two categories spectrum average values extremely approach, SVM also can separate these two categories according to these limited samples .But for remote sensing image ,characteristic dimension generally is many, moreover the category spectrum is quite close in the panchromatic image. Appling SVM to remote sensing image of the multi- spectral, the high spectrum or the high spatial resolution can obtain good effect, also can enhance the remote sensing image classification precision. This classified method is insensitive to the noise, increases the classification precision, suits the non-linear classification, the classification result is neat, suits GIS, extremely suits to four wave bands high resolution data. The following(see Figure 2) is the classification result

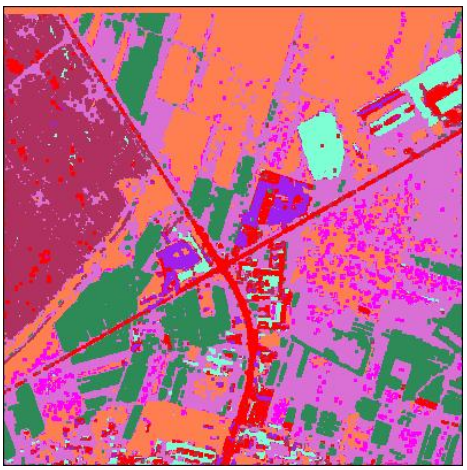

Figure 2 The result of Support Vector Machine Classification

Stochastically selects 30 ground control points to carry on the precision analysis, the reference [19] thought that the extracting result quality has very big relation with the initial clustering, whether clustering precise is high or not plays a important role to the road. This method classification overall precision achieves 88.406%, the kappa coefficient is 84.4%.(see Figure3).

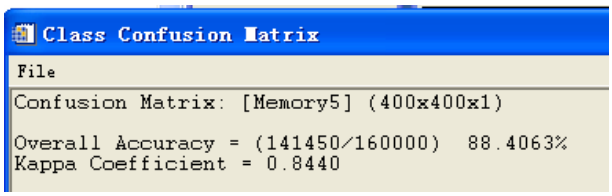


Figure 3 Precise Analysis

### 2.3 The research of road extraction experiment

**2.3.1 Morphology processing:** Carried on morphology processing using the mathematics morphology operation, such as Open, close, erode, dilate and so on. First change the clustering image into binary image using the morphology function- im2bw, then process the binary image with the mathematic morphology algorithm. We can see from the binary image(see Figure 4), Around the path there is much disturbance which is caused by the spectrum error such as " different objects with same spectrum ", "same object with different spectrum" And the roof that has the same spectrum as the road and so on, so in order to extracting the road net information to reject these disturbances is very important. After repeatedly experiments we select the long line structure element according to the road structure, se0=strel('line',12,30), se1=strel('line',10,120).Separately carried on the close operation using the two structure elements , remove the tiny noise, at the same time ,separate noise that adheres to road information , this step is especially important, in a sense, the selection structural element has decided the road information in extraction scale. In this image the road information is quite tiny in disorder, therefore we use smaller size structural element, maintain detail. of the road .But because of the road information geometry characteristic complex and changeable, so the structural element used in this paper cannot use in common, we can select appropriate structural element according to the road collective situation, or choice different structural element to carry on processing many times, in order to achieve the most superior effect. After the close operation, the main road information displays separately in the close operation result images, but there is also the non- road information outside the branch road , which is caused by the segmentation result ,we may remove the irrelevant information using "bwareaopen "function, in order to obtain the integrity road information, after we add the two close operation result images together to obtain the integrity road information, the we use thin function to obtain the road median line, the image of figure 5 is the road median line image.

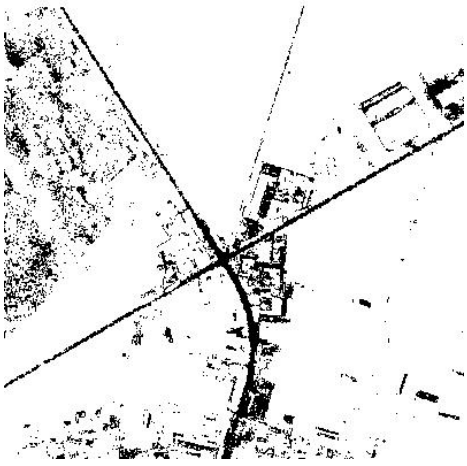

Figure 4 The binary image

**2.3.2 Using the seed growth algorithm to eliminate the short line, extract the road median line that has certain length and direction:** We can see from figure 5, we have already roughly obtain the road median line, but because ofthe image itself characteristic and mathematics morphology Limitation, there are many irrelevant short lines. in order to eliminate this irrelevant short lines, extract more precise road information. the seed growth algorithm is used in this paper. From the image we can see the image DN is 0 and 1,we put the image into a two -dimension matrix, the road DN is 1,we search the road information according to the following rules:

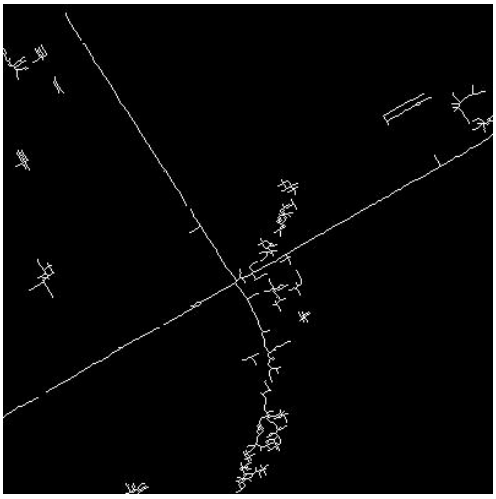

Figure 5 Road median line extraction

First, looks for a pixel point whose value is one, judges whether it had been searched, if not, then it is as seed growing point;

Second, Store the seed points to the matrix -road seed (),then search seed point's eight neighborhoods to look for the pixel elements whose value is one, if this point has not searched then it is put into another matrix seed ();

Third, take a point from the matrix seed() as a seed point, duplicates the second step, until the matrix seed() is empty;
Forth, Judge the matrix road seed(),if the element integer is bigger than five pixels elements then it belongs to the road median line, otherwise rounded down;

Fifth, store the new matrix roodseed() into the another matrix -rood(), and clear the matrix of roadseed()empty, then redundant one step , until all pixel elements of the matrix road() have been scanned;

Sixth, read-out the matrix road(), then output a binary image, this image is the extraction road median line.

The image of figure 6 presents the extraction result. Figure 7 shows the superposition result, the Figure 8 is another experiment area.

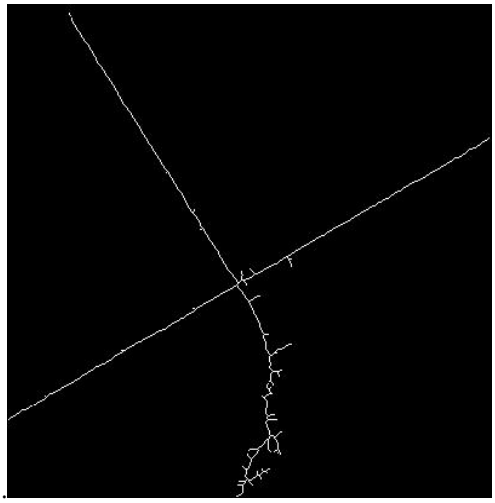

Figure 6 The final road median line extraction

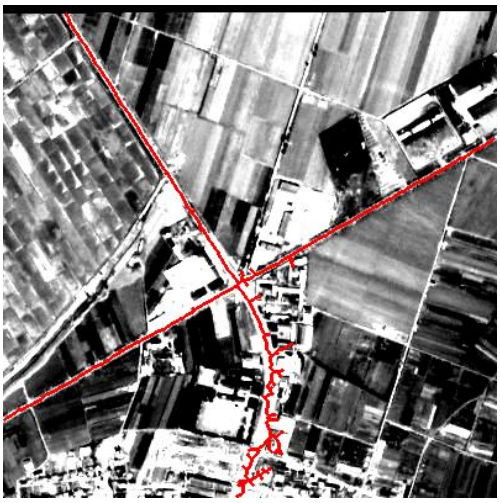

Figure 7 The Superposition result

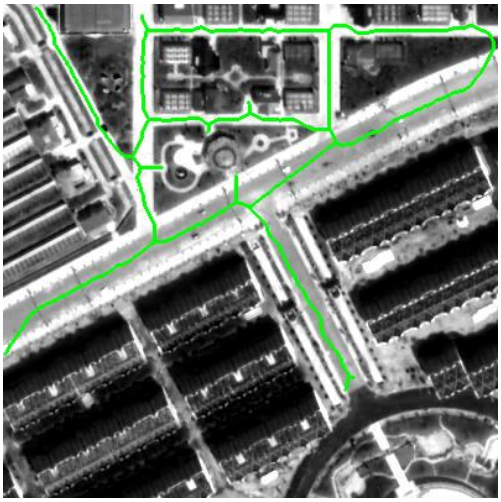

Figure 8 The another experiment area road extraction

## 3. CONCLUSION AND FORECAST

This paper has realized road network information extraction from the high resolution remote sensing image, by the method - mathematics morphology and the seed growth .we can see from the figure 7 and figure 8, this method has extracted the road network information well, especially has the superiority in extracting the road detail information.

From the above experiment we know that :1) if we can fully understand and describe geometry characteristic and the spectrum characteristic of the objects information, and select appropriate structure element, , we can extract majority road information that satisfies certain size and geometry by the mathematics morphology method., especially as the road geometry shape is complex ,changeable ,detail numerous and diverse;2) the improvement method of region growth - seed growth, which eliminates burr in the road median line and the non- road shoreline and more effective improves extraction precision;3)in actual production process, the people need extract other objects in the remote sensing image , such as the rivers network, the building, the inhabitant and so on, these objects all have their own unique geometry and the spectrum characteristic. Therefore, the road information extraction thought may expand to other remote sensing image objects extraction.

At the same time , we also find that, because of the limited of the mathematics morphology theory and the complex of road information in the remote sensing, there also has its deficiency in the experiment:1) As the extraction objects and the noise has the same geometry and spectrum characteristic, the morphology method is no longer effective; 2) Different objects processing needs different structure elements, However, currently, structure element selection doesn't unification theory basis, in this paper the structural element selection has been in the certain experience foundation, through experimental analysis definite.;3) the extraction result through mathematics morphology processing is decided by the image segmentation result in the great degree ,therefore, if we use a more highly effective segmentation method, we may unify it with the existing some other methods, especially the context information, or the texture information method ,we would increase the precision.

This paper gives priority to mathematics morphology and gives assistance to the seed growth method, compared with the independent mathematics morphology or seed growth, the extraction precision has been improved, this has a vital significance for the research area such as the targets extraction, the GIS data regarding, automobile navigation, urban planning, and map digital and so on. Using many kinds of extraction methods to unify, the multi-scale multi-temporal multi-spatial resolution image fusion, extracting the high precise road information will become the hot research spot in the future.

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