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A Summary on Methods for Urban Vegetation Information Extraction from Remote Sensing Images

Zhao Xu-yi [+], Jiang Pei-xuan and Liu Nai-zhong

Remote Sensing Wuhan University, People's Republic of China

Abstract. Obtaining vegetation information by Remote Sensing is the important field in Remote sensing research. At present, extracting vegetation information of city by the Spatial Distribution of Spectral Characteristics is still the mainstream method. This essay summarizes the current condition of urban vegetation extraction based on remote sensing images. Meanwhile, the essay introduces several representative methods for extracting vegetation information by consulting literatures. In addition, it also makes comparison with these methods' processes, summarizing their advantages and disadvantages and come up a few thinking of the author.

Keywords: Remote Sensing Image, Urban Vegetation Information Extraction, Spectral Characteristic, Precision

1. Introduction

Remote sensing technology is being widely applied in the fields of ecology, land utilization, environmental change research since it is capable of integrating data, comparing data as well as observing large areas synchronously[1], repeatedly and economically without disturbing the object directly [2]. In practical applications, the vegetation survey is the vital field of remote sensing and it becomes the fast, accurate and objective way to obtain vegetation information in the monitoring, evaluating, management of city.

In recent years, researchers have come up with a variety of new theories and methods to extract vegetation information through remote sensing images of which there are categorized into two main methods: The first is based on the Spatial Distribution of Spectral Characteristic and the other refers to the outside knowledge such as Expert knowledge, Neural Networks, Wavelet Transformation and GIS. These new methods are playing a vital role in the urban vegetation extraction [3].

2. Urban Vegetation Extraction Methods

2.1. Bands composition

The results of Visual Interpretation and information extraction will be greatly depended on the band selection of Multi-Spectral images. At present, it is very common to rely on Human Experience to analyze and judge which band to select. For instance, we know that TM4, TM3 and TM2 of Landsat7 can reflect vegetation information, especially TM4, which corresponds to the peak reflection of vegetation thus reflecting more vegetation information. So the composition of RGB324 is usually used in the interpretation of vegetation in remote sensing images to some degree.

As for the method of band selection, Mingguo Ma[4] proved that original TM 432 Bands Composition Method can extract vegetation information in a satisfied way by the visual interpretation of Jinta oasis. Bo Nian[5] had combined the Spectral Characteristic, band usage and OIF Parameter Method to select the

[+] Corresponding author. Tel: 15071462209.
E-mail address: zhaoxuyi555@gmail.com

optimum band. The experiment result proved that it works because it makes up the defects of OIF Parameter Method and in favour of increasing the difference between Spectral Characteristic.

The advantages of Band Composition are that it contains much spectral information with simple operations, short time and relatively low cost. The disadvantages of it are that the distinction ability is greatly determined by the band selection and the accuracy may not be quite satisfying.

2.2. Vegetation index

Using Vegetation Index to extract vegetation from TM image is a reasonable way considering the aspects of technology and economy. The regular methods of Vegetation Index include NDVI, DVI, RVI, PVI and GVI, all of which eliminate External Factors through different combination of band and this combination can meet demands of various remote sensing applications.

Single Factor Analysis and Multiple Comparison (single factor analysis variance，multiple comparison) is used by LuoYa[6] as the verified method to compare actual effect of different Vegetation Index extraction. Figure 1 demonstrates the process in detail.

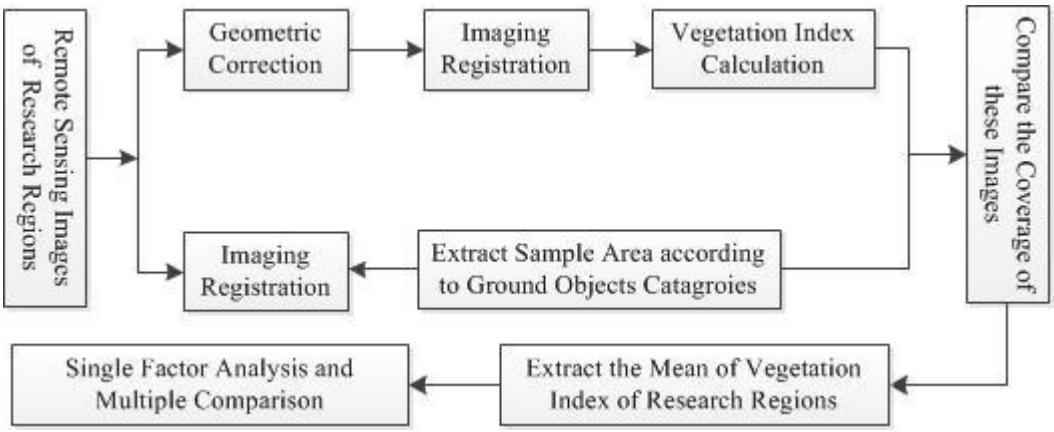

Fig. 1: Vegetation Index process and evaluation

The result of this experiment proves that though the vegetation information is intensified and easy to extract after TM image is calculated by the Vegetation Index, it still has different effect according to different methods. If these methods should be evaluated by the degree of differences as the evaluation standard, the final effect sequence from superior to inferior is NDVI、RVII、TNDVI、DVI、EVI、GVI.

The advantages of this method lie in its mature technology, easy operation as well as its good result which is proved by the experiment of Pengxiang Zhao[7] who compared three image enhancement technology (Density Slicing, Data- Differential , Vegetation Index). At the same time, Jirui Zhu[8] concluded from his compared experiment with regions of Guilin using RVI、NDVI、TNDVI that NDVI is the prior choice of Remote Sensing Synthesis Index because it has the property of Band Ratio Characteristics, thus avoiding the influence of terrain.

The defect of this method is that it can only distinct between vegetation and non-vegetation but has little ability to precisely subdivide non vegetation. What's more, the Resolution Capability of Vegetation Index is easily influenced by the outside conditions such as atmosphere, colour of soil and leaves, density and types and the area of vegetation all of which may decrease the resolution of the Vegetation Index [9].

2.3. Combination of NDVI with band composition

In the process of extracting vegetation information, the light condition may be different due to terrain undulation, thus leading to the phenomena of "same object with different spectra "or "same spectra with different object" which leave obstruct in the classification. At this time, combining NDVI with bands composition may bring better result.

Lili Zhao [10] extracted vegetation information of Shenzhen by means of ETM+ image and the result showed that because the difference between TM3 band and TM4 band is larger, the difference calculation of them benefits the green space information acquisition. So the combination of NDVI with TM3, TM4 band

has the optimum result. While Wenzuo[11] Zhou used similar method in the ecological environment of Nanjing and the result is relatively satisfying.

The combination of NDVI with band composition method is sensitive to the vegetation transformation because the difference calculation of different reflectivity highlights urban green space information. Additionally, it is little influenced by the high level of terrain undulation. However, result of the experiment shows that it has similar problem with pure NDVI method though it is better than the initial band composition method.

2.4. Grading and classification method

Nowadays, regions that need classification become much larger because of the increasing requirement of remote sensing and errors also become quite common. Subdividing the certain regions and operating them in different levels will solve the problem

Grading and Classification Method is the one to analyze spectral characteristic through visual interpretation, spectral analysis and other auxiliary data, and then to compare the spectral characteristic differences between vegetation and other ground objects, and to classify images in different levels step by step. Youshui Zhang[12] discussed this method based on IKONOS image of Nanjing and took correspond way to extract information of each level.

This means fully takes into account the characters of different objects and avoids mixing classification that classification method only by spectral characteristic may bring about. In addition, this method solves the problems of measurement of city's Urban Green Coverage Rate. Finally, by combing with other image data such as hyper spectral image or aerial image, it can even identify the types of vegetation in details, thus greatly satisfying the actual need.

The disadvantage of this method is that it still has some mixing classification and precision needs to be further improved. What's more, it is difficult to distinct the vegetation area in the shade since it is easily mixed with other objects which have similar spectral characteristics in this circumstances.

2.5. Object-oriented method

The usual approaches used in automatic extraction of remote sensing images have shared the character that they extract information using pixel as the basic unit when describe the digital surface model. With the wide range of applications of high-resolution remote sensing images, limitations of image analysis methods based on the pixel become increasingly obvious in remote sensing applications. Spatial entities interested in high-resolution remote sensing images are a set of pixels and spatial fragmentation are more obvious, which increases the uncertainties of image analysis. If quantifying the properties of the surface features which is categorized by spectral information of pixels, misclassification will become very evident because of the lack of description of surface features categories by spatial information and textural features.

Zanyou Su [13] proposed Object-oriented multi-scale segmentation method to test the Wuyi Mountain National Nature Reserve for the study area. The method uses Mask Technique and characteristics between classes to extract surface features. The result of the experiment confirms that this method is effectual and high-precision in the classification of the complex terrain area. Hengtong Fan [14] employed the object-oriented method to conduct the extraction and classification of urban vegetation by using IKONOS images. This experiment achieved more satisfactory results. Figure 2 shows the detailed process of this method.

The advantage of this method is that it considers the Texture Effects inside the categories and correlation information between adjacent pixels which leads to high-precision. The result of the experiment demonstrates that the classification precision of this method in urban vegetation is higher than the common-used methods based on the pixel.

The defect of the method is that the relatively sparse vegetation prones to be mixed classified. Moreover, because the method is object-oriented, the result of segmentation has a powerful influence on the classification precision. Additionally, all segmentation parameter sand subsequent extraction methods need further study on account of the immature of this method.

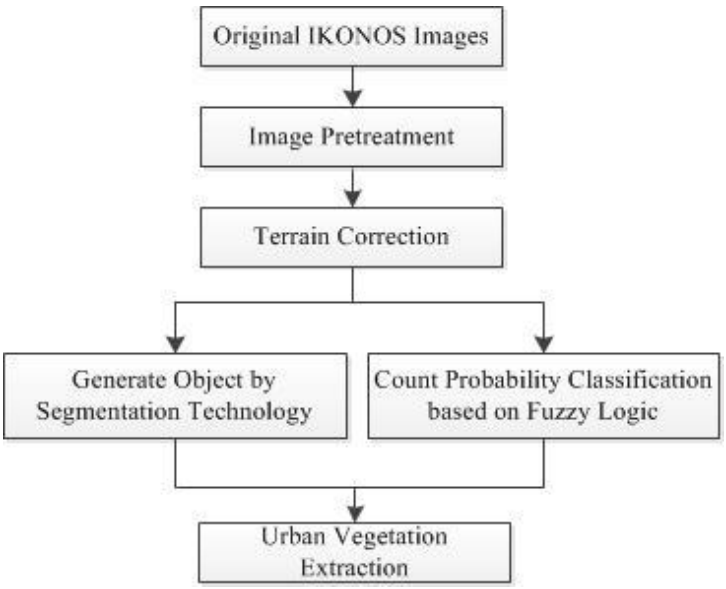

Fig. 2: Object-oriented Method process

3. Summary and Outlook

The number of extracting vegetation methods based on the remote sensing images is on the rise at present but Bands Composition, Vegetation Index are still the popular ones. These methods have high precision in vegetation extraction but still have some defects. The essay summarizes these methods' advantages and disadvantages and concludes that integrated utilizing these methods in a proper way can greatly increase the accuracy of vegetation extraction. For instance, it is reasonable to use the Combination of NDVI with Band Composition. One can anticipate that after preliminary extraction using NDVI, if then adopt Combination of NDVI with Band Composition which has higher precision or other simple but practice methods, there will be high chance of higher precision result. So how to comprehensively utilize the various kinds of information and advantages of extraction methods to increase precision becomes extremely urgent for the sake of service for environmental monitoring, ecology protection or related service for departments of forestry, agriculture and so on. Meanwhile, it is also the research direction of many researchers.

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