High Spatial Resolution Remote Sensing Image Classification Based on Pixel Shape Index Method

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Abstract. Then the pixel shape index method is used to extract the pixel shape index features of high spatial resolution remote sensing images and supplement the spectral features. The experimental results show that the pixel shape index feature can effectively distinguish the ground objects with similar spectral features but different geometric shapes, and is superior to the spectral feature classification method in accuracy. Compared with the small ripple feature method and the multi-scale region feature method, the pixel shape index method also achieves better results. On the other hand, it is found in the experiment that the method is easily affected by the detailed information in the high spatial resolution remote sensing image, and the classification effect of the region rich in detailed information is not ideal. In this paper, pixel shape index method is used to effectively distinguish ground object targets with similar spectral features but different shapes, and extract pixel shape index features of high-resolution remote sensing images. Compared with spectral features, pixel shape index features have great advantages in accuracy, and it is also conducive to the supplement of spectral features.

Keywords: High spatial resolution, Pixel shape index, PSI, Image classification.

1. Introduction
With the improvement of the spatial resolution of remote sensing images, the spatial features provided by images have been greatly enriched. At the same time, due to the inevitable reduction of spectral resolution, a large number of phenomena of "same spectral heterogeneity" and "same spectral heterogeneity" result in the loss of certain precision of image classification in spectral domain. Since it is difficult for spectral features to fully describe the targets in high spatial resolution remote sensing images[1], it is particularly important to make up for the deficiency of spectral features by extracting spatial features such as texture, shape and geometric structure. In this chapter, a pixel shape index...
method is used to describe the shape and structure characteristics of pixel context, and the image features are extracted from the perspective of spatial shape and geometric structure, in order to make up for the shortcomings of traditional spectral methods [2].

When the spatial resolution of remote sensing images is improving faster and faster, and the spatial features provided by the interior are becoming more and more rich, it also brings a lot of problems in image information and spectral resolution quality [3-5], which leads to a lot of problems in the grasp of accuracy in image classification. How we end up with different methods for high-resolution images of textures, shapes, structures, geometric features and other objects that are difficult to describe by spectral features becomes critical. In this paper, a method based on pixel shape index is used to describe the characteristics of the above-mentioned effects [6], which makes up for the shortcomings of traditional spectral information extraction methods [7-8].

2. Pixel shape index
The design principles of Pixel Shape Index (hereinafter referred to as PSI) are as follows [9]: (1) the spectral similarity between central Pixel and adjacent Pixel is used to consider the spatial context relationship of Pixel; (2) make the pixels in the same shape region have the same or similar eigenvalues, which is to enhance the homogeneity of high spatial resolution remote sensing images and smooth noise to a certain extent; (3) Expand the eigenvalues between pixels of different shapes as much as possible in order to make full use of the detail characteristics of remote sensing images with high spatial resolution [10].

Based on the above design principles, PSI defines a series of direction lines that pass through the central pixel. By using this set of direction lines to construct multidimensional features, namely pixel shape index features, the spectral features of remote sensing images with high spatial resolution are supplemented [11].

Pixel Shape Index, referred to as PSI (Pixel Shape Index), is based on design principles and defines a series of direction lines through the central pixel [12]. These direction lines are set to construct multi-dimensional features, namely Pixel Shape Index, to supplement the spectral features of high spatial resolution remote sensing images.

2.1. Extraction of direction lines
The PSI feature of a pixel is, in a sense, the feature of the directional line set of the pixel, so the extraction of PSI first lies in the extraction of the directional line [13]. The direction line is defined as a line segment with an Angle of Π/D starting from the center pixel (xCenter, yCenter) and extending to both ends, and the conditions for the expansion of the first line segment.

2.2. PSI feature extraction
After obtaining the set of orientation lines of any pixel (I, j), the length of each orientation line in the set is calculated, and the sequence of orientation lines length D(I, j) = [d1, d2... dD] of any pixel (I, j) is obtained. Sequence according to the length of the pixel’s orientation line.

3. Feature extraction method for comparison
3.1. Small ripple feature method
Wavelet coherence characteristics is a common texture feature extraction method, the influence of its advantage in and under a certain scale, to the separation of fine-grained details, space for signal changes of the highly recognition ability, high sensitivity, therefore, we can often put small ripple bedding extraction as texture measure of a certain scale. Each pixel in the image corresponds to a window, and the energy value of the sub-image of the wavelet transform is taken as the feature vector.
3.2. Multi-scale feature method
The multi-scale feature method is to combine a series of Windows of different sizes and extend the pixel features of the Windows in the neighborhood. Such a strategy can well simulate the recognition effect of the classification target. Finally, the features extracted at different scales are classified and fused to get the multi-scale feature classification results.

4. Experimental process and analysis

4.1. Data selection
In this experiment, the shooting data of WorldView-2 satellite were selected and part of high-resolution images were selected. In the experiment, the spectral values of three visible bands, red, green and blue, were taken as the spectral features of the image, with a size of, and a spatial resolution of 0.5m, as shown in Figure 1.

![Fig. 1 Image diagram of original data](image.png)

4.2. PSI method experiment
Firstly, the PSI method is used to extract the image features, and then the normalization and spectral features are combined, and the classification results are obtained by input into SVM. The classification accuracy of PSI method was 84.66%.

![Fig. 2 PSI classification results](image.png)
As can be seen intuitively from the above classification results, it is difficult for the PSI method to be correctly identified for the relatively fine cement road. Meanwhile, PSI features will reflect great differences with many water features, and it is easy to make mistakes in the re-classification of buildings, which is a great regret of this method.

4.3. **Experiment of small ripple feature method and multi-scale regional feature method**

(1) Classification results of small ripple feature method

![Small ripple classification accuracy = 73.01%](image1)

**Fig. 3** Classification results of small ripple features

In the classification and extraction of buildings and cement roads, the wavelet texture-theory feature method shows high classification accuracy, which adopts the big window for the inner pixel of the target object, and the small window clasp for the outer pixel of the edge, greatly reduces the noise phenomenon, and obtains good classification results for the extracted targets.

(2) Classification results of multi-scale regional feature method

![The classification accuracy of multi-scale regional features was 75.37%](image2)

**Fig. 4** Classification results of multi-scale regional feature method

From the above classification results, it is not difficult to see that the multi-scale regional feature method can clearly distinguish and more accurate classification for buildings and vegetation crops with different color shades. However, there are still misclassification between light vegetation and
water body, and between buildings and cement road surface. The reason is that the extracted regional features are still spectral features at different scales, which is also a serious disadvantage of the classification method.

5. The experimental conclusion
Shape index based on pixels high score in the remote sensing image classification method, give priority to with PSI method, the geometry and structure similar goal has a very good description of the difference, especially for the shape more rules of building a strong ability to recognize, can better to distinguish between similar spectral characteristics and geometric shapes different goals, this is one of its obvious advantages. However, for high-resolution images with rich detailed information, this method is easy to be disturbed, and the classification results are not so obvious. In conclusion, PSI achieves the highest value in classification accuracy. Compared with other methods, including multi-scale regional feature methods and small ripple feature methods, PSI is a reasonable, effective and feasible extraction method for impact classification.

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