Interpretation of Real Information-missing Patch of Remote Sensing Image with Kriging Interpolation of Spatial Statistics

Feng Yiming, Lei Xiangdong, Lu Yuanchang

Research Institute of Forest Resource Information Techniques, Chinese Academy of Forestry, Beijing 100091, China, fengym@forestry.ac.cn

Abstract: The aim of this paper was mainly to interpret the real information-missing patch of image by using the kriging interpolation technology of spatial statistics. The TM Image of the Jingouling Forest Farm of Wangqing Forestry Bureau of Northeast China on 1 July 1997 was used as the tested material in this paper. Based on the classification for the TM image, the information pixel-missing patch of image was interpolated by the kriging interpolation technology of spatial statistics theory under the image treatment software—ERDAS and the geographic information system software—Arc/Info. The interpolation results were already passed precise examination. This paper would provide a method and means for interpreting the information-missing patch of image.

Keywords: Spatial Statistics, Remote Sensing Image, Information-Missing Patch, kriging interpolation

1 Introduction

When the TM image is classified, we usually meet the phenomena of unknown real pixel information of partial regions on the image because of the shelters of cloud, cloud shade, soot and others. In order to solve this problem, sometimes we adopt another period image, but this needs pay extra-expense. Using the pixel around the real information-missing patch to interpolate the information-missing patch is a meaning solving such problem. We usually adopt the classical interpolation models (including inverse distance weighting and bilinear interpolation), but the obtained results were not satisfied with our requirements. Because the spatial distribution of land object has self-correlation, namely the nearer the things or phenomena in space are, the similar their characters are. The spatial distribution of land objects complies with the distribution rule of geography, so the analysis technique of geostatistics is the most suitable method to interpret information-missing patch of image. For these reasons, we in this paper present such method applying kriging interpolation method to interpret the real information-missing patch of image.

2 Data

The TM image (resolution of 30m*30m) of Jingouling Forest Farm of Wangqing Forestry Bureau of Northeast in China on 11 July 1997 was selected, which was used to classify the plant types. A patch (the range of 130° 6’3”~130° 7’31”E and 43° 18’10” ~43° 19’13”N, and the biggest diameter of information-missing patch of 25 pixels) with cloud from the TM image was adopted, which was our experimental data of kriging interpolation. The data of forestry sources survey (forest layer map and corresponding attribute database) in 1997 were used as the precise data to check the accuracy of classification results and kriging interpolation results.

3 Method

3.1 Classification of Remote Sensing image

Land use type of Jingouling Forest Farm is mainly forest. According to the local conditions and the image characters as well as based on the *Main Technique Rules of Forest Resource Survey* enacted by the People Republic of China in 1982, the TM image was classified as 5 categories. They were coniferous forest (A), broad-leaved forest (B), mixed forest (C), other land use types of forestry (D) and cloud and its shade (E). According to the classification signs (including image color and image texture, and so on), some patches (that could be identified easily as the trained sample from image) were selected, and the maximum likelihood supervised imagery classification method was applied to classify the TM image, thus obtaining the land covered type map. Using the forest layer map and the corresponding attribute database as the examination data of classification precision, a general classification precision of 80.25% was obtained.

3. 2 Kriging interpolation

There are some patches (whose real information was not identified) on TM image because of cloud shelter, which is justly satisfied with our experience requirement. The following problems on how to apply the kriging interpolation method to restore the real image information of sheltered patches were discussed. The whole work process was conducted under the environments of the Remote Sensing image treatment software (Erdas 8.5) and the GIS software (Arc/info 8.10).

1) Data preparation

In the Erdas software, the patches with cloud and cloud shade from the Wangqin image were used as the data source of kriging interpolation method. The image pixel values were exported as the ASCII format file. In the Arc/Info software, the ASCII format file was imported and showed by the map mode. The imported data were edited and the pixel points of cloud patches (polygons of P2 and P4 of Figure1.) and cloud shelter patches (polygons of P1 and P3 of Figure 1.) were deleted. The results of map edited were showed in the Figure 1. Moreover, the Figure 1 was used the map of conducting spatial statistic analysis and spatial interpolation.

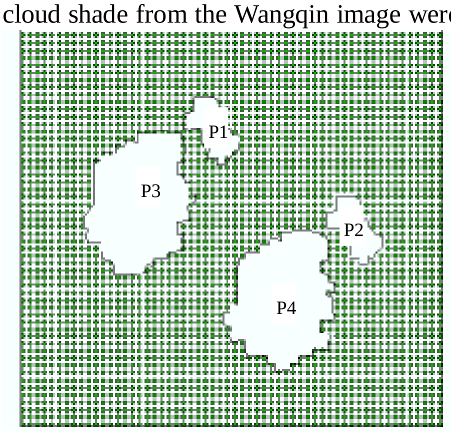

Fig.1. Results of map edited

2) Semivariogram model fitting and interpolation

Based on the extended module (Geostatistical Analyst) of Arc/Info, both the semivariogram model fitting and the kriging interpolation were conducted according to the pixel values of red band, green band and blue band.

Kriging method was to conduct the interpolation based on the information (provided by semivariogram function analysis) of variable spatial self-correlation degree. Hence, the accuracy of interpolation had direct correlation with the precision of semivariogram model fitting. The process of semivariogram model fitting mainly includes the following steps: confirming the curve type of model, optimizing the parameters of estimation and checking the fitting model. The pixel values of red band, green band and blue band were isotropy in the process of model fitting. Comparing the fitting accuracy of different theoretical models, the semivariogram fitted by the exponent model was the best. The fitting parameters of semivariogram models of pixel values of red, green and blue bands were showed in the Table1.

Table 1 Fitting parameters of semivariogram models of pixel values of each band

band type	model	nugget	sill	nugget/sill	range(m)
red	exponent	0.94794	2.7804	34.1	867.15
green	exponent	150	**185**	27.0	829.73
blue	exponent	20	**120**	16.7	829.73

The data in the Table 1 showed that the pixels values of three bands had certain sill values, so the pixels of three bands had the property of stabilization or approximate stabilization in the research region. The nugget:sill ratios of red and green bands varied from 25 to 75%, indicating that the pixels values of red and green bands had moderate spatial correlation. However, the nugget:sill ratio of blue band was less than 25%, indicating that the pixels value of blue band had very strong spatial correlation. Results in table 1 showed that it was rational to utilize known pixel values of each band to estimate unknown pixel values.

Semivariogram graph fitted by exponent model of pixel values of green band was showed in Figure2. Checking results of fitting model showed that fitting models were satisfied with requirement. Operation of other band was the same as green band.

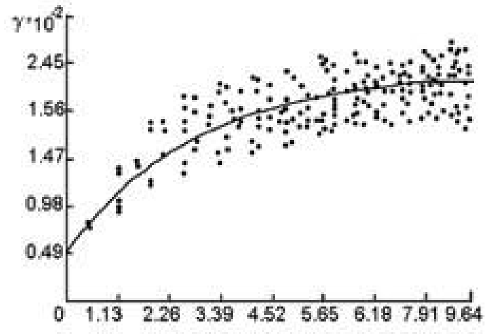

Fig.2. Semivariogram model fitting of green band

3.3 Reclassification of pixels interpolation results in information-missing region

Interpolation results of each band were translated into raster data in Arc/Info software respective. We reclassified the image map recombined by interpolation results according to the classification factors established at 3.1. Comparing the results of reclassification with the map of forest layers of forest resources survey, the interpolation classification accuracies of 4 information-missing patches in figure 3 (P1,P2,P3 and P4) were 80、76.7、80 and 76.7%, respectively. Information of information-missing patches was restored after it was subjected to the kriging interpolation treatment of geostatistics.

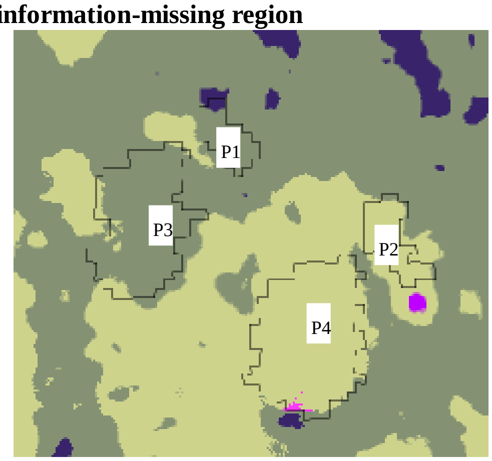

Fig.3. Classification results of interpolation

4 Discussion

1) The kriging interpolation method used in this paper, belongs to Mathematical Statistics from the angle of methodology, but it grasps the fact (that the spatial distribution of land object has continuity and self-correlation) from the angle of theory, so the estimation accuracy is higher.

2) If the area of information-missing patches is too big, namely, the diameters of information-missing patches were bigger than the maximal distance－the range of spatial interpolation, the application of kriging interpolation method has not practical significance.

3) If there is some pixel information different from surrounding pixels or some complicated and changeable surface characteristics in the information-missing patches, we must depend on some other information (including topography and our learning about local conditions) and combine kriging interpolation method, so as to obtain the better results.

Acknowledgements

This paper was finished under the support of the tenth-five year key Project (2001BA510B0705).

References

[1]Curran P.J.,1988.The Semivariogram in Remote Sensing: An introduction,Remote Sensing of Environment.24: 493-507.

[2]Issaks E.H,& Srivastava R.M, 1989.An introduction to applied geostatistics,Oxford University Press,NY.

[3]M. Chica-Olmo,2000.Computing geostatistical image texture for remotely sensed data classification, Computers and Geosciendes. 26(4):373-383.

[4]Robertson G.P, 1987. Geostatistics in ecology: Interpolating with known variance, Ecology, 68(3):744-748.

[5]Webster R.,1985.Quantitative spatial analysis of soil in field, Advance in Soil Science, 3:1 ～70.