Extraction and Analysis of Contour Line Curvature Based on Different Algorithms Post-print

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Abstract

Contour curvature is an important topographic attribute that reflects the convexity and concavity of terrain surfaces in the horizontal direction, expressing the divergence and convergence patterns of surface material movement. Based on vector contour data and DEM of the Xian' angou small watershed in Ansai County, contour curvature was extracted using circle fitting algorithms (adjacent three-point method, interval three-point method, and least squares method) and surface fitting models (E-model, S-model, and Z-model), respectively. Through comparative analysis with actual terrain, the results demonstrate that: (1) In the calculation results from vector contour data, the three-point fitting method exhibits greater differences compared to the least squares method and provides a more accurate description of the spatial pattern distribution of contour curvature; (2) The results calculated by the least squares method show the highest degree of concentration in frequency distribution, while the frequency curves of the two three-point fitting methods exhibit minimal differences; (3) In the calculation results from raster digital elevation models, the results based on the S-model show greater differences in spatial pattern compared to those of the E-model and Z-model, while the calculation results based on the E-model provide a better description of contour curvature. These results can accurately illustrate the differences in calculating contour curvature using different algorithms, hold significant importance for practical digital terrain analysis, and can provide an important reference for contour curvature calculation.

Full Text

Extraction and Analysis of Contour Curvature Based on Different Algorithms

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Abstract

Contour curvature is one of the fundamental topographic indicators that reflects the convexities in the horizontal direction of the topographical surface and expresses the divergence and confluence patterns of the motion of the surface matters. Calculating the contour curvature can measure the information conversion rate of the DEM interpolated by the vector contours, and provide a reference for setting the appropriate DEM resolution. This study, based on vector contour data and DEM of Xiannangou watershed in Ansai County, Shaanxi Province, China, used the circle fitting algorithms (adjacent three-point method, interval three-point method and least squares method) and surface fitting models (Evans model, Shary model and Zevenbergen model) to calculate the contour curvature respectively. The comparative analysis between the real topography of the site and the computational results indicated as follows: (1) The results from the three-point fitting method are different from the results using the least squares method, and the former describes the spatial pattern distribution of the contour curvature more accurately. (2) The frequency distribution of the results calculated by the least squares method is the highest, and the difference between the frequency curves of the two three-point fitting methods is small. (3) In the calculation results of the DEM, the results from the S-model display a larger difference than that by the E-model and the Z-model in the spatial pattern. The calculation results based on the E-model have a better effect on the contour curvature description. The difference presented by this paper when using different algorithms to calculate the contour curvature provides important reference in retrieving the contour curvature information in the practical digital terrain analysis.

Keywords: digital terrain analysis; digital elevation model (DEM); contour curvature; circle fitting algorithms

1. Study Area and Data

The study area is the Xiannangou watershed in Ansai County, Shaanxi Province, China. The elevation ranges from 1070 m to 1429 m with a relief of 260 m. The slope gradient is 30°. Vector contour data and Digital Elevation Model (DEM) data were used for the extraction and analysis of contour curvature.

2. Methods

This study employed three circle fitting algorithms (adjacent three-point method, interval three-point method, and least squares method) and three surface fitting models (Evans model, Shary model, and Zevenbergen model) to calculate contour curvature. Previous research by Florinsky [4] and Schmidt [5] has contributed to the development of quantitative methods for land surface analysis using DEMs.

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Note: Figure translations are in progress. See original paper for figures.