AN APPROACH TO REDUCE BOUNDARY DISTORTION IN COMPRESSING GRID DEM WITH WAVELET TRANSFORM

Zhanqiang CHANG [1, 2], *Huili GONG* [1, 2] *Xiaomeng LIU* [1, 2]

[1] Capital Normal University, 105 West 3rd Ring North Road, Beijing 100048, China

[2] Key Lab of 3D Information Acquisition and Application, Education Ministry of China

1. RESEARCH BACKGROUND

Digital Elevation Model (DEM) is the core data for three-dimensional visualization and geographical spatial analysis. With the implementation of Digital Earth, the amount of various DEM data is rapidly expanding. In order to compress DEM data, researchers ever put forward two kinds of DEM compression methods: (1) Generic entropy encoding compression; (2) Converting grid DEM to TIN DEM [1][2]. In recent years, a great progress has been obtained in the investigation of compressing DEM data with wavelet transform [3]. However, there is still a sticky problem in wavelet transform, i.e. the boundary distortion, needed to be solved.

2. BOUNDARY DISTORTION IN WAVELET TRANSFORM

As it is well know, wavelet transform is more suitable than Fourier transform in processing the complicated spatial data, which that contain a wide range of frequency components, and wavelet transform is completely reversible in theory if no quantization implemented. However, many related researches demonstrate that there really exists difference between the original signal and the restructured one even if no quantization implemented [4]. The difference between the original signal and the restructured signal, i.e. boundary distortion, mostly happens near the boundaries of the signal as shown in Fig.1.

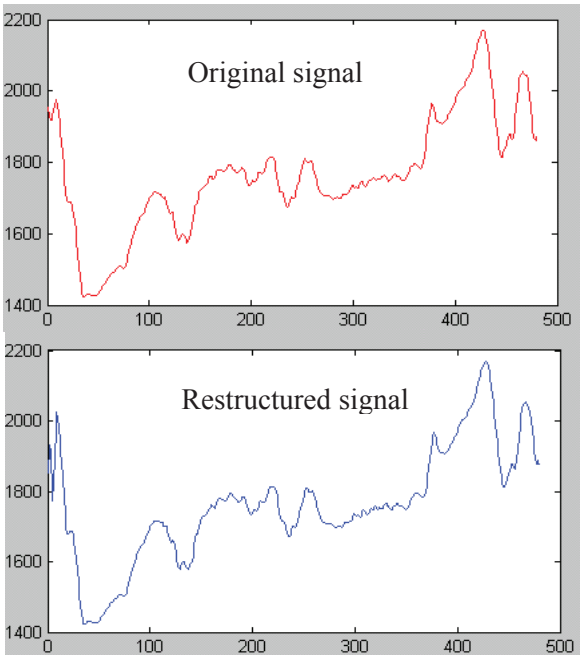

Fig.1 Difference between original and restructured signals

Obviously, the boundary distortion will seriously reduce the precision of reconstructed DEM data and the compression ratio.

3. AN APPROACH TO REDUCE BOUNDARY DISTORTION

Many investigations indicate that the influence factors leading to boundary distortion include boundary expansion, sub-sampling, the stability and relativity of the signal near the boundary and the non-linear phase of the used wavelet filter [4-7]. In order to reduce or diminish the boundary distortion, some measures have been generally taken, including expanding signal with periodical expansion or bi-periodical expansion and selecting a symmetric bi-orthogonal wavelet filter, even so the boundary distortion can not be eliminated completely. The boundary distortion phenomenon is a stubborn problem to be solved in wavelet transform. A lot of researches show that boundary distortion degree depends to a great extent on the nature of the signal itself. Generally, if the signal keeps stable, the boundary distortion degree commonly remains less. On the contrary, it will apparently get serious[4][8]. Unfortunately, most DEM data, especially the mountainous DEM data, generally inheres in the nature of instability, fragmentation, and less relativity, so that the degree of boundary distortion will consequentially be more severe and the precision of reconstructed DEM data seriously reduced.

By analyzing the distribution of boundary distortion in wavelet transform, the authors put forward an approach to reduce the boundary distortion degree in compressing grid DEM data with wavelet transform, the fundamental idea of which is transforming the boundary problem of two-dimensional wavelet transform into the boundary problem of one-dimensional wavelet transform so that the area of boundary distortion is enormously diminished. Accordingly, the precision of the reconstructed DEM data can be obviously improved.

4. EXPERIMENTAL RESULTS

Some experiments on compressing mountainous DEM data were made by using the algorithm we proposed. In the experiments, we focused on three aspects to comprehensively evaluate the grid DEM data compression effect: (1) Compression ratios; (2) Standard deviation between original DEM data and the reconstructed DEM data; (3) Comparison between the visual effects. The results demonstrated ideal compression performances, involving high compression ratios (around 20 times), less standard deviation and excellent visual effect. Fig.2 displays comparison between cubic perspectives of the original and the reconstructed DEM data, it seems rather difficult to distinguish from each other with human eyes.

5. CONCLUSIONS

Wavelet transform is a rather efficient tool for data compression. However, due to the difference between the characteristics of various data, e.g. image data or grid DEM data, there really are differences between the concrete implementing techniques. The authors put forward an approach to reduce boundary distortion in compressing grid DEM data with wavelet transform so that excellent compression performance is yielded, involving higher compression ratios, less standard deviation and excellent visual quality. It is of practical significance in the applications such as massive DEM database and three-dimensional GIS.

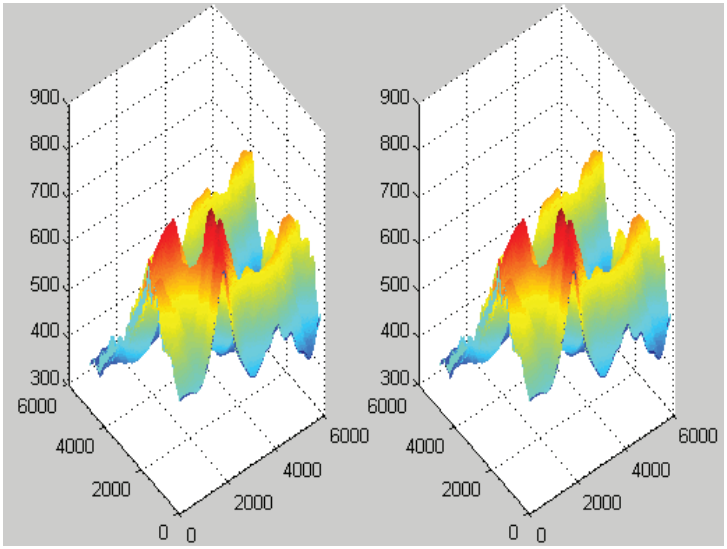

Fig.2 Comparison between the cubic perspectives of original and reconstructed DEM data

6. REFERENCES

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