Geospatial Aspects of Merging DTM with Breaklines

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Introduction & Motivation

❖ DED constitute a central component of all mapping and GIS fields, supporting an infinite variety of applications affecting numerous areas of life.

❖ A variety of sophisticated technologies (digital photogrammetry, IFSAR, LIDAR, etc) resulted in huge availability of automatic elevation data.

❖ The surface data obtained by applying these automatic techniques is not sufficiently reliable, and requires additional characteristic data such as breaklines.

❖ Integrating breaklines in DTM is a part of the bigger challenge of modeling three-dimensional surfaces and is an important issue, due to cost / benefit considerations.

❖ Presented here is an analysis of improvements in the accuracy of surface representation following application of different breakline incorporation techniques.

Theoretical Background

❖ Breaklines (or characteristic lines / skeleton lines) are linear elements that describe changes in smoothness or continuity of the surface.

❖ Preservation and integration of breaklines is most essential to obtaining a reliable DED.

❖ The input in the process of integrating breaklines in the DTM is the elevation model (gridded, triangulated or quadrangles networks) and a collection of three dimensional breakline vectors.

❖ The objective is to integrate these lines in the model in a representation that would facilitate obtaining a more unified and accurate database.

❖ Two principal approaches to dealing with this problem:

- *Integration into CDT with breaklines as mandatory segments.*
- *Breaklines incorporation by one of the surface interpolation methods*

The Research

❖Objective:

- *Examination of the extent to which integration of breaklines affects the accuracy of the relief description, while taking note of 3 relevant techniques.*
- *The study focuses on a common procedure of integrating breaklines in a relatively sparse elevations grid, for obtaining elevations grid of higher resolution and greater accuracy.*

The Research

❖Measuring Reference Data

Test areas

- *Photogrammetric Block on a scale of 1:12500 based on GPS GCPs.*
- *Two accurate (0.5m) high resolution (2m) DTM areas collection.*

❖Measuring Breaklines

Measured Breaklines

- *Basic objective - performing graduated integration and analysis*
- *Six breakline layers based on significance and altimetric division:*
  - ➢ *Main upper breakline*
  - ➢ *Typical upper breakline*
  - ➢ *Secondary upper breakline*
  - ➢ *Main lower breakline*
  - ➢ *Typical lower breakline*
  - ➢ *Secondary lower breakline*

The Research

❖Experiments Methodology

- *Thinning out the fine grids into sparse grids with resolutions of 25m, 50m, 100m, and 200m.*
- *Integrating gradually the six breakline layers into the sparse grids and computing new 2m grids.*
- *Performing comparative analyses at each stage (including average deviation, standard deviation, maximum deviation and deviation histogram) respective to the original dense grids.*
- *All statistical analyses was carried out in three versions – full coverage, buffer_20m and buffer_10m.*

Buffer demonstration

Conclusions

❖ It is possible to reach high reliability with sparse grids integrated with breaklines respective to very dense grids.

❖ Both the “Centered TIN” method (representing the CDT approach) and the “Bilinear Profiles” method (representing the surface interpolations approach) brought about a significant improvement in accuracy of surface representation

❖ The major improvement in accuracy is obtained after adding the two main breakline layers (upper and lower).

❖The CDT algorithm approach is better suited to the breakline areas themselves, while in relatively “rounded” areas, surface interpolations are preferable.

❖ A combination of the two methods would probably yield better results than either of the methods separately.

The Research

❖ Inserting Breaklines with “Diagonal TIN”

Technique | Results

- *Transformation of elevations grid into TIN using grid’s diagonals.*
- *Integretaion of breaklines using CDT.*
- *Computing dense grid using linear TIN interpolation.*

❖ Inserting Breaklines with “Centered TIN”

Technique | Results

- *Transformation into TIN using bilinear calculation of grids center point.*
- *Maintaining the previous mechanism.*

❖ Inserting Breaklines with “Bilinear Profiles”

Technique | Results

- *Two perpendicular bilinear calculations using breakline intersection points in cells with breaklines.*
- *Simple bilinear interpolation in breakline-free cells.*

The End !

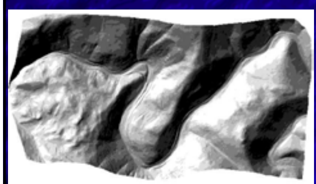
Future work

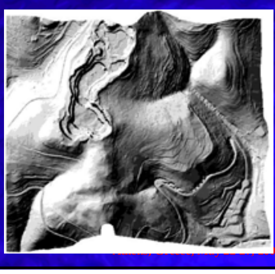
❖ Cost / benefit analyses while handling additional statistical parameters.

❖ An altimetric separation analysis using the presented examination scheme.

❖ Refining algorithms and tools developed for the presented study.

The Two Test Areas

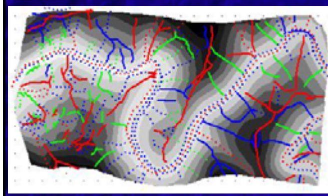


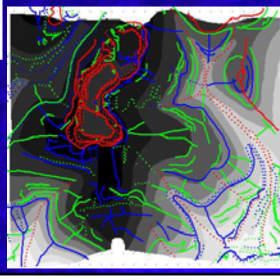


Figures

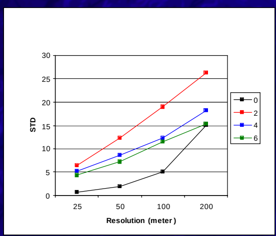
Buffer Demonstration

The Six Layers of Measured Breaklines





Inserting Breaklines with “Diagonal TIN”



Full coverage:

Deterioration in all parameters.

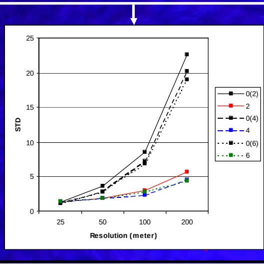
Improvements in isolated cases.

Buffer 10:

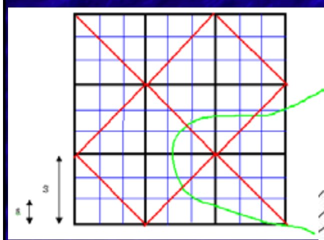
For 100m & 200m grids integrated with the 2 major layers:

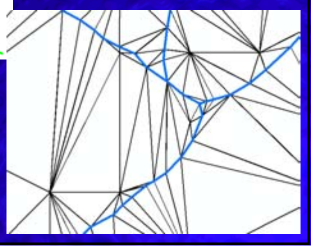
Average improvement rate – 75.

Maximum improvement rate – 85.

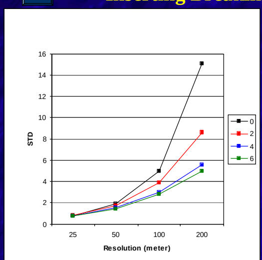


Inserting Breaklines with “Diagonal TIN”





Inserting Breaklines with “Centered TIN”



Full coverage:

Improvements in all parameters.

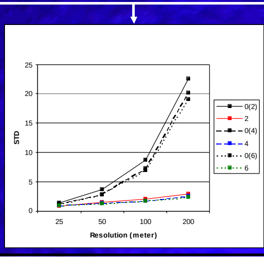
66 % improvement rate in STD for 100m & 200m grids integrated with the 6 layers.

Buffer 10:

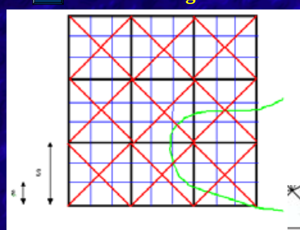
For 100m & 200m grids integrated with the 2 major layers:

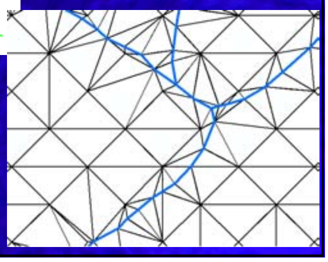
Average improvement rate – 84.

Maximum improvement rate – 89.

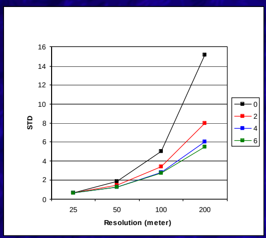


Inserting Breaklines with “Centered TIN”





Inserting Breaklines with "Bilinear Profiles"



Full coverage:

Improvements in all parameters.

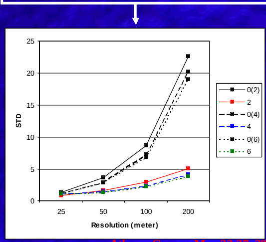
62 % improvement rate in STD for 100m & 200m grids integrated with the 6 layers.

Buffer 10:

For 100m & 200m grids integrated with the 2 major layers:

Average improvement rate – 72.

Maximum improvement rate – 77.



Inserting Breaklines with "Bilinear Profiles"