Digital Elevation Model Approximation from Stream Networks: A Reversed Approach

Mehran Ghandehari
MSc of GIS
Department of Geomatics, College of Engineering, University of Tehran, Iran
1. Overview

2. Fundamental Geometric Structures

3. Background

4. Proposed Method

5. Conclusions & Future Work

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M. Ghandehari
Department of Geomatics
University of Tehran

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1. Overview
Digital Elevation Model (DEM)
1. OVERVIEW

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A Reversed Approach

An Approximation

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2. Fundamental Geometric Structures
Voronoi Diagram

2. Fundamental Geometric Structures

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Georgy Voronoi
1868-1908
Delaunay Triangulation

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2. Fundamental Geometric Structures

Duality

Voronoi Diagram

Delaunay Triangulation

Sample Points

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Skeleton (Medial Axis)
Instability of Skeleton

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One Step Crust and Skeleton Algorithm

Christopher Gold and Maciek Dakowicz (2000)

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Stream Network Topology

- Stream network topology: Horton (1945), Strahler (1957), Shreve (1966), and Tokunaga (1978)
- Stream order methods
Modeling of Stream Erosion

Branching structure of stream networks
A stable voronoi-based algorithm for skeleton extraction through labeling sample points (Karimipour and Ghandehari, 2012).
Catchment Area Delineation

Catchment area delineation from the skeleton of stream networks

(Gold and Snoeyink, 2005) (Karimipour, Ghandehari, and Ledoux, 2013)
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4. PROPOSED METHOD

Skeleton Extraction of Stream Networks

- Sampling
- Improved one step crust and skeleton algorithm

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Extraction of Elevation Points
Stream Ordering

- A global parameter
- Shreve method
- The NVS Vector Stream tool
- The modified elevations are computed using the following formula:

\[ H_c(p) = H_0(p) + \frac{H_{\text{mean}}}{\text{Order}(p)} \]

where
- \( H_c(p) \) = the modified elevation of point \( p \)
- \( H_0(p) \) = the initial elevation of point \( p \)
- \( H_{\text{mean}} \) = is the mean elevation of all elevation points
- \( \text{Order}(p) \) = the order of point \( p \)
DEM Interpolation

- Inverse Distance Weighting (IDW)
- Ordinary Kriging
- Natural Neighbor
4. PROPOSED METHOD

DEM Interpolation (Cont.)

IDW

Kriging

Natural Neighbor

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4. PROPOSED METHOD

DEM Interpolation (Cont.)

IDW  Kriging  Natural Neighbor

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4. PROPOSED METHOD

DEM Interpolation (Cont.)

IDW  Kriging  Natural Neighbor

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DEM Interpolation (Cont.)

Natural Neighbor
- A well-defined set of neighbors
  (spatial adjacency relationships )
- A well-behaved weighting function
- A continuous model
- Low computational requirements
- A smooth interpolation
- Well-defined stream banks
DEM Interpolation (Cont.)

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- **Natural Neighbor**
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$O(n \log n)$
DEM Interpolation (Cont.)

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Conclusions

- Automatic catchment area delineation using only the vector-based stream network
- Extracting elevation information implicitly on the basis of stream network properties
- Using the skeleton and order of stream networks to approximate the DEM
- Although our approach is not appropriate for accurate terrain analysis, for non-exact large-scale analysis, it is fast, efficient and yields good results.
- By using well-known data structures, retrieving the original data, constructing topology and improving of the proposed method can all be done easily.
Recommendation & Future Work

- Using supplementary data
- Making a better simulation of water flows
- Introducing new applications for the produced DEM
  - Hydrological analysis
  - 3-D terrain reconstruction
Thanks for your attention