Towards Medial Axis-based simplification of LiDAR point clouds

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Introduction
Why Medial Axis?

Chapter 4 Generalization of a DTM surface through skeleton extraction of 2D slices of a ridge is a leaf of the skeleton. The set of leaves defines a three-dimensional feature - a ridge (Figure 4.9).

Construction of a vertical parent-child hierarchy between leaf skeleton branches can be performed similarly to the construction of a hill. The skeleton leaves if they lie close to each other in the vertical projection to the XY plane form a vertical path topologically related to the ridge line.

Figure 4.10: Construction of the parent child relationship for contour lines representing a ridge: source contour lines with their skeletons (a), two ridge lines (b) and the vertical paths defining skeleton relationships for the ridges (c).

An example of such a hierarchy is presented in Figure 4.10. A single hill from the model is considered here. The hill contains two major ridge lines marked in blue in Figure 4.10 (b). At the same time, for the contour lines a vertical hierarchy can be constructed forming the sequence ABCDEFG. As seen in the figure the skeletons of the contour lines are composed of one polyline. Assuming that there exists a "root" point on the skeleton, two branches are created. The two branches are leaves of the skeleton and together with leaves from other skeletons form two vertical hierarchies. Each of the two hierarchies is related to one of the ridge lines. The sequence A1...G1 (Figure 4.10 (c)) exists owing to

Dey et al., 2001
Tam & Heidrich, 2003
Matuk, 2006

Dakowicz & Gold, 2003
Medial Axis Transform
Current goal

Simplification of LiDAR point clouds:
Reduce number of points while maintaining detail.
E.g. for creation 3DTOPO10NL
Methods
MAT approximation

Shrinking ball algorithm
(Ma et al., 2012)
Metrics on the MAT

local feature size
(Amenta 1998)
LFS-based decimation
LFS-based decimation
Noise
Dealing with noise
Dealing with noise
Metrics on the MAT

separation angle
(e.g. Attali 1996)
Metrics on the MAT

separation distance
(Chazal 2005)
Simple noise detection

Based on thresholding:
1. Not so discriminative
2. Many MAT points are lost
My proposal

Consider series of shrinking balls for every point
Observation

Even for noisy points, ‘good’ ball is computed
How to recognise ‘good’ ball?

Look at development of ball metrics

![Graph showing angle (deg) and radius (wrt initial) over iterations for a good point](image1)

![Graph showing angle (deg) and radius (wrt initial) over iterations for a noisy point](image2)

- **Good point**
- **Noisy point**
Getting a denser MAT by keeping ‘good’ balls
Results
Results

dataset:
Rotterdam 2012
(30 pt/m²)
Results

unmodified shrinking ball algorithm

Top view

Side view
Results

modified shrinking ball algorithm

Top view

Side view
Simplification to ~10%
Thank you
References


Workflow

- DSM
  - Construct MAT
    - Analyze MAT using importance measures
    - Recognize features in MAT
    - Generalize MAT
    - Database of features (Application specific)
  - Reconstruct DSM
    - Generalized DSM
Medial Axis Domain

\[ S \xrightarrow{\mathcal{M}} \mathcal{M}[S] \xrightarrow{\mathcal{M}^{-1}} S' \]

1. Analysis
2. Generalization
3. \[ \mathcal{M}[S] \]
4. \[ S' \]