Contour Extraction and Visualization from Topographic Maps

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Overview

The goal is to take an input map image and extract the contour data such that the information can be used for further GIS processing or for map visualization.

The approach leverages the fact that contours are often a distinct color on maps, and that contours can be expected to be closed either with themselves or the edges of the map.

Approach

Segmentation
- Convert RGB to HSV
- Segment based on color (often orange-brown)

Line Thinning
- Perform morphological thinning such that lines are only 1 pixel thick

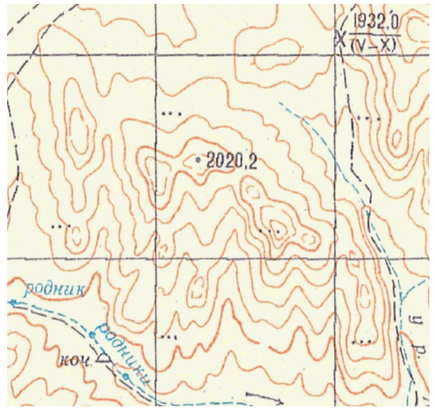
Contour Extraction
- Extract initial contours using Moore neighbor tracing
- Remove contours below a threshold length

Edge Restoration 1
- Delaunay Triangulation to close gaps in contours
- Repeat until stable

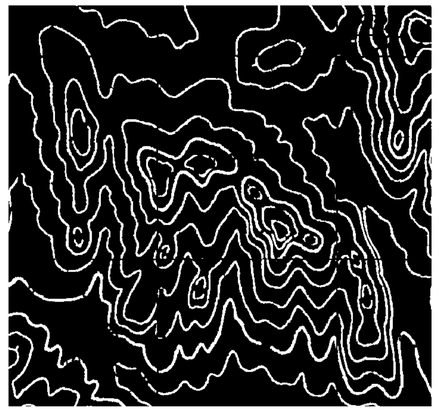
Edge Restoration 2
- Close additional edges using smallest Euclidean distance between ends
- Return to Restoration 1; repeat until stable

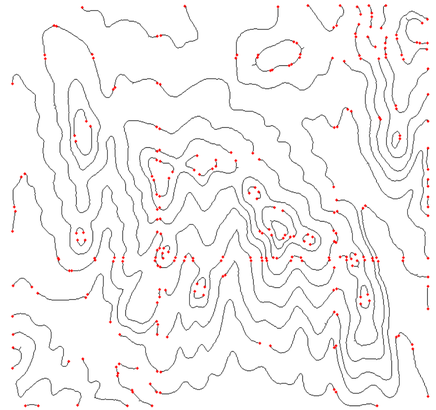
Model Construction
- Use closed contours to construct a 3d surface representation of the map

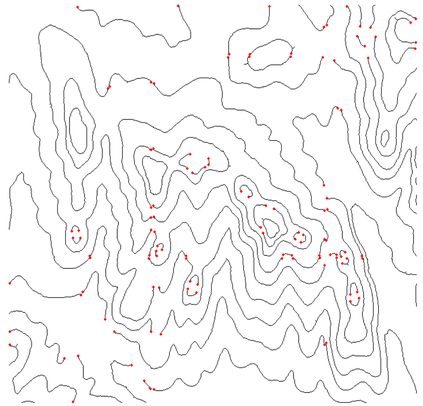
Results

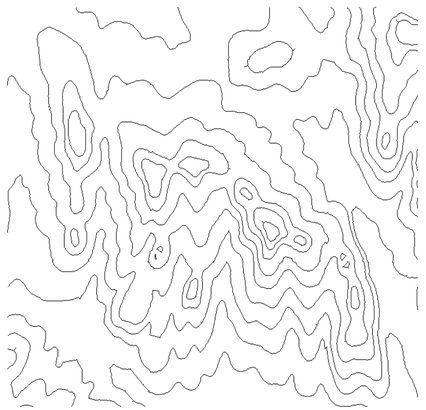


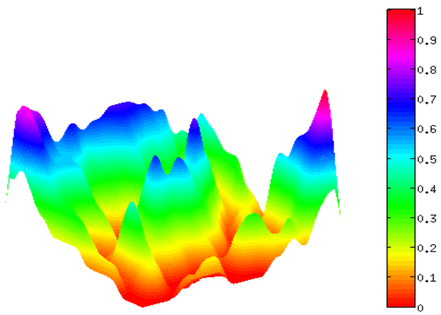
Original image


Post Segmentation


Line Thinning and Contour Extraction


One Iteration of Delaunay Triangulation


Post Reconstruction



3D Surface Construction

Challenges and Further Work

Though contour extraction yields good results for well formatted maps, further work would be needed to address map formatting issues. In particular, contour lines that are closely spaced may blend together during segmentation. Also, contour lines that either vary in color or share the same color as other map objects would segment badly.