HORIZONTAL HACHURES

Patrick Kennelly
Dept. of Earth and Environmental Science, Long Island University,
720 Northern Blvd., Brookville, NY 11548. USA.
email: Patrick.Kennelly@liu.edu

Abstract

Horizontal hachures are form lines of equal elevation that provide a textured oblique hill shading effect to terrain maps. Imhof (1982) differentiates horizontal hachures from contours in three manners. First, horizontal hachures are "more compactly and evenly arranged" than contours. Second, "no exact elevation value is assigned to the individual hachure line." By contrast, elevation contours are generally drawn at nicely rounded elevation values, separate by a constant contour interval, and labeled intermittently with the elevation value. Finally, "the thickness of the [horizontal hachure] lines is not constant, usually following the principle of oblique lighting." Imhof (1982) also proposes the use of an extremely fine stroke pattern of horizontal hachures to supplement contours. This paper looks at ways to create horizontal hachures from closely space contour lines. Results can provide a textured hill shading effect for non-illuminated areas, create more continuous horizontal hachures for both illuminated and non-illuminated terrain, or be used to supplement contours for highlighting both form and shading of terrain.
Keywords: horizontal hachures, contours, slope hachures

1. Introduction

Horizontal hachures, as displayed in **Figure 1** (from Imhof, 1982), are a subset of a type of lines that are commonly included in maps to display relief. Fall lines are drawn in the direction of maximum gradient, and form lines, including horizontal hachures, result from the intersection of a horizontal plane with the topography.

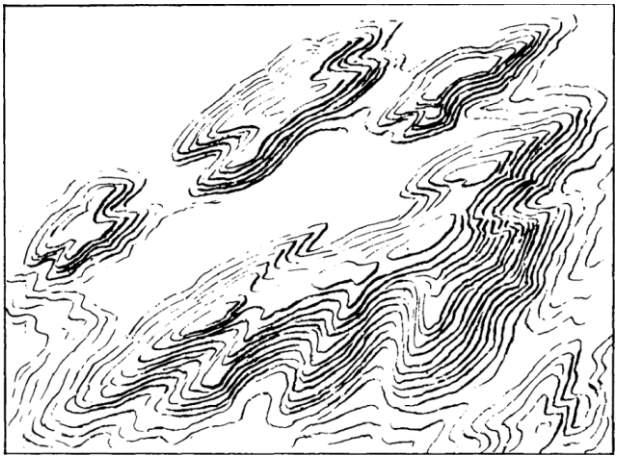

Figure 1: Horizontal hachures from Imhof (1982), figure 154, p. 231.

Fall lines include the short lines of variable thickness typically referred to as hachures. A quantitative methodology for creating these hachures was documented by Lehmann (1799), first computer-automate by Yoeli (1985), and more recently integrated into various cartographic methods in studies by Kennelly and Kimerling (2000), Hurni et al. (2001), and Samsonov (2013).

Form lines include horizontal hachures and contours. Imhof (1982) differentiates horizontal hachures from contour lines in three manners:

- Horizontal hachures are more compactly and evenly arranged than contours
- In contrast to contours, no exact elevation value is assigned to the individual hachure line
- The thickness of horizontal hachure lines is not constant, usually following the principle of oblique lighting

Although Tanaka's (1950) relief contour method and Yoeli's (1983) shadowed contour method uses contour lines of variable thickness, both use specific elevation values and regular contour intervals.

The horizontal hachuring technique shown here varies the density as opposed to the thickness of contours, using more compactly arranged contour line segments to create an oblique lighting effect.

2. Methodology

The methodology begins with a digital elevation model (DEM) of the summit of Mt Hood, Oregon. It is comprised of 92 x 111 grid cells, with each cell edge measuring 26.3 meters. The elevation model is rendered with oblique illumination to create a hill-shaded grid.

The elevation grid is then contoured at a one-meter interval, resulting in 1,356 contour lines. Each point is then buffered using a radius 13 meters. This ensures, for this grid cell size, that the resulting buffer polygons are nearly but not quite tangential. Lines are then clipped to the circular polygons and only the lines coincident with points are selected.

The hill-shaded grid is converted into a point layer, resulting in 10,21 points that inherit the value of hill shading darkness. The contour line segments from the first iteration are buffered with the hill shading values, all contours are clipped, and only clipped contours coincident with points are selected. Two additional iterations of the previous step are conducted to achieve the final display.

3. Results

The map of Mt. Hood rendered with this methodology is displayed as **Figure 2**. The inset map shows a traditional hill-shaded map of the same DEM. The tonal variations associated with horizontal hachures conform to illumination from the northwest and inclined 45° above the horizon.

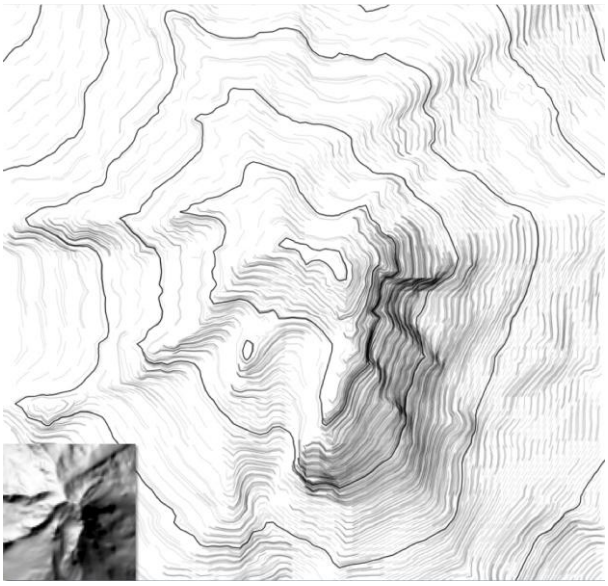

Figure 2: Horizontal hachure map of Mt. Hood, Oregon produced with the methodology described here.

Contours at a 200-meter interval have also been added to the display to show the form of the volcano in areas of sparse horizontal hachures. The display enhances areas of sparse hachures by using a larger buffer distance to capture longer contour line segments.

4. Discussion

This procedure was designed to create a map displaying relief shading, but with detailed texturing. The methodology is also designed to avoid sharp edges, which were apparent if the hill-shading grid was classified, converted into polygonal outlines and used to clip the contour lines. By generating contour segments from points and iterative buffers, more heavily shaded areas undergo a smoother transition to less heavily shaded areas.

5. Summary

Horizontal hachures are a method of modulating contour lines to achieve relief shading with oblique illumination. This shading is realized using fine lines that also provide a distinctive texture to the resulting map. Variations in the number and shape of line segments within the original grid cells of the DEM add visual detail at a finer granularity than shaded grid cells. Horizontal hachures may be supplemented by traditional contours that highlight the form of the terrain features of interest.

6. References

Hurni, L, B Jenny, T Dahinden and E Hutzler, 2001, Interactive analytical shading and cliff drawing: Advances in digital relief presentation for topographic mountain maps, *Proceedings*

of the 20th International Cartographic Conference, 6-10 August 2001, Beijing, China, 3384–3391.

Imhof, E, 1982, *Cartographic Relief Presentation*. Walter de Gruyter, Berlin and New York.

Kennelly, P and A J Kimerling, 2001, Modifications of Tanaka's Illuminated Contour Method, *Cartography and Geographic Information Science*, 28(2), 111-123.

Lehmann, J G, 1799, *Darstellung einer nueun Theorie der Bergzeichnung der schiefen Flächen im Grundriss oder der Situationszeichnung der Berge*, Leipzig.

Samsonov, T, 2013. Morphometric Mapping of Topography by Flowline Hachures. *The Cartographic Journal*, 51: 63-74.

Tanaka, K, 1950, The relief contour method of representing topography on maps, *Geographical Review*, 40: 444-456.

Yoeli, P, 1983, Shadowed contours with computer and plotter, *The American Cartographer*, 10: 101-110.

Yoeli, P, 1985, Topographic relief depiction by hachures with computer and plotter, *Cartographic Journal*, 22: 111-124.