Generating Hiking Route Maps

Wesley Willett CS294-10 (Visualization)

Problem & Motivation

When navigating using a map, hikers in mountainous terrain must make judgments about *relative direction, cardinal direction, grade, distance, elevation, roughness,* and *terrain type* in order to help correlate locations in the real world (including their own) with locations on the map.

Plan-view topographic maps **[Figure 1]** provide this information, but even advanced users can have a hard time visualizing the terrain based on them. 3D oblique maps provide a more immediate mapping from the real world to the map and facilitate easier perception of relative grade, elevation and terrain roughness and manually generated versions occur frequently in hiking and skiing guides. **[Figure 2]** However these maps generally introduce occlusions and sacrifice accurate distance and angular measurements.

In general, resolving issues like occlusion and inconsistent distance measurements in printed 3D maps is difficult. However, given a constraint - a specific route or set of routes, for example - we can generate maps that preserve relevant information, prevent occlusions, and provide hikers with easier access to important information about elevation, grade, and the shape of the local terrain.

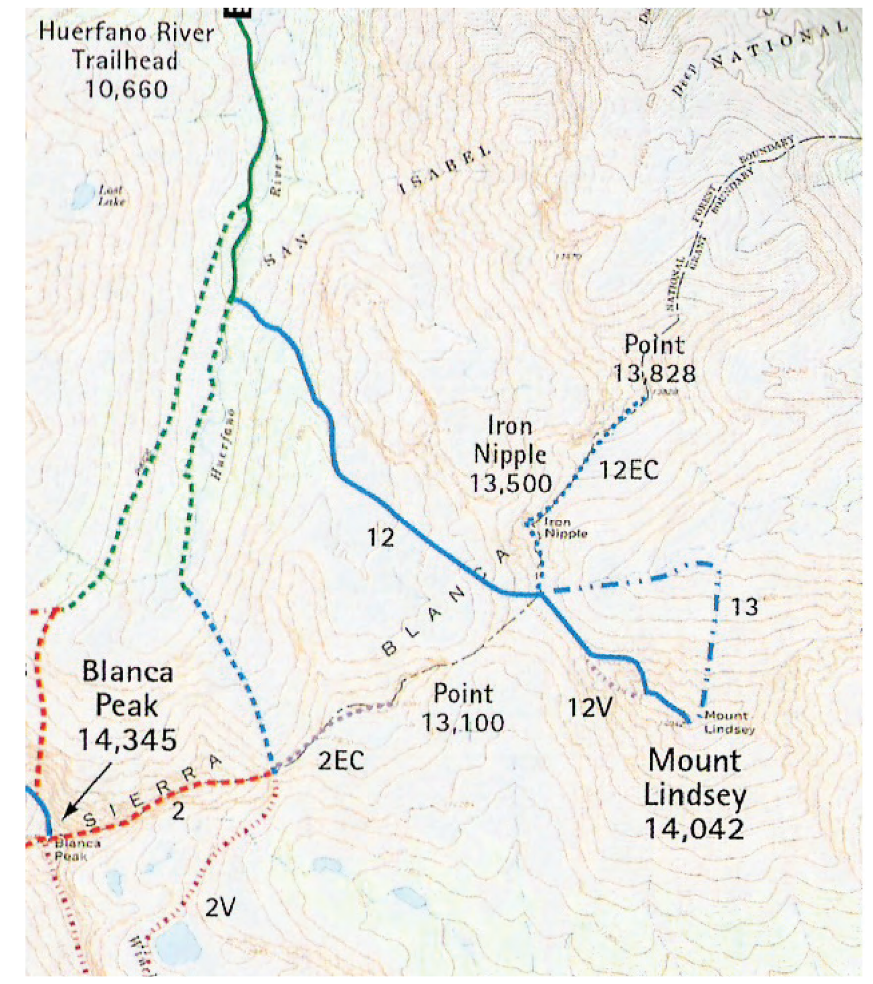

Figure 1. Topographic map showing northern ascents of Colorado's Mount Lindsey and Blanca Peak taken from a mountaineering guidebook.[3]

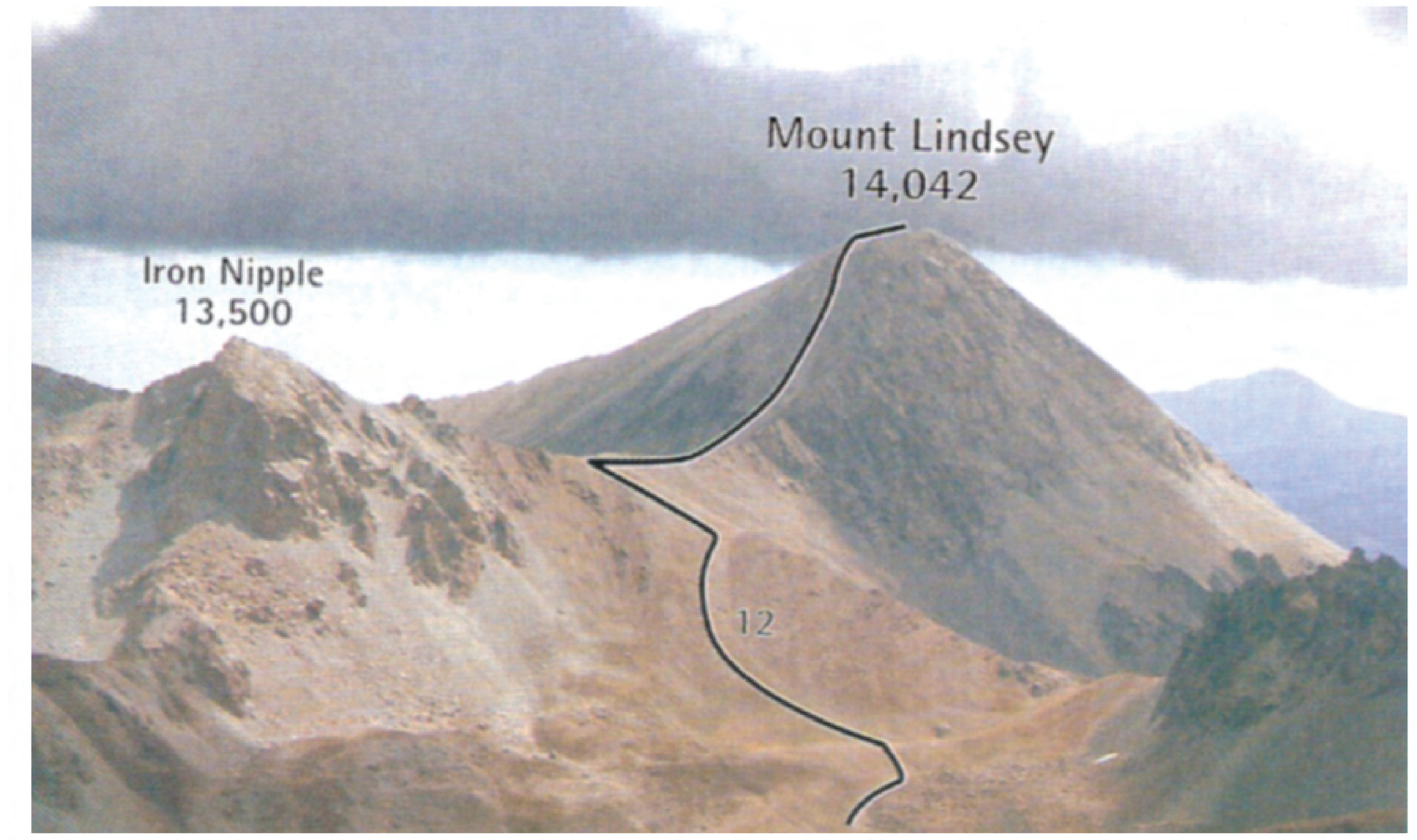

Figure 2. An alternate view of the primary route on Mount Lindsey (seen in blue on the previous map) from the same guidebook.[3] Guides often include these sorts of oblique representations - either from hand-drawings, traced photographs, or manually generated using GIS tools.

Approach

Our system is ultimately intended to create printable 3D oblique maps of hiking, biking, and other outdoor routes automatically based on GPS tracks. To create a map, a set of points describing a route is input to the system. The route is then overlaid on 3D elevation model of the scene.

Using *simulated annealing,* we select an optimal viewpoint into the 3D scene that accommodates the path, minimizes occlusions, and maintains an appropriate viewing angle Terrain heights are also exaggerated to aid relative grade and elevation judgements. The system is built using the NASA World Wind Java SDK.

Vertical Exaggeration

By varying the amount of vertical exaggeration applied to the scene, we can produce images which convey a clearer relationship between the relative heights and slopes of in the scene.

Viewing Angle

Different viewing angles into the scene can drastically effect the perception of terrain and the occlusion of tracks. We constrain viewing angles to the 30-45 degree range recommended by Haeberling [1].

Future Work

Shading - Currently, the underlying 3D elevation model is draped with satellite imagery, but does is not shaded. Shading the final models using appropriate lighting [1] should help alleviate some of the difficulty in distinguishing depths. Unfortunately, shading is not supported in the current World Wind Java core renderer, and the timeline for inclusion is ambiguous.

Decoration - Distance, elevation, start/finish, and landmark labels like those seen in the example image above will be rendered atop the final map images in future iterations. A compass rose should also be included to help establish cardinal directions.

Terrain Distortion - While the current system is capable of exaggerating *all* of the vertical heights by a constant value, rescaling and repositioning individual terrain elements may also prove valuable [2 ,4]. In future versions of the software, we hope to be able to automatically isolate and modify terrain features in order to clarify complex maps.

Evaluation - Although 3D oblique maps and related representations are widely used, their perceptual effectiveness has not been thoroughly evaluated. We hope to perform a controlled study of the resulting maps in order to assess their effectiveness as a navigation tool.

[1] Haeberling, C. 2004. *Selected design aspects and graphic variables for 3D mountain maps*. In: Proceedings 4th ICA Mountain Cartography Workshop 2004, Vall de Núria (Spain); Monografies tècniques, num. 8. Barcelona. 109–117.
[2] Patterson, T. 2000. *A View from on High: Heinrich Berann's Panoramas and Landscape Visualisation Techniques for the U.S. National Park Service.* Cartographic Perspectives 36: 38–65.
[3] Roach, 1999. *Colorado Fourteeners - From Hikes to Climbs.*
[4] Takahashi, S., Ohta, N., Nakamura, H., Takeshima, Y., and Fujishiro, I. 2002. *Modeling surperspective projection of landscapes for geographical guide-map generation*. Computer Graphics Forum 21, 3, 259--268.