BENDING TYPE TO REPRESENT THE THIRD DIMENSION OF TERRAIN ON MAPS

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ABSTRACT:
Many 3D maps show type with considerable distortion, resulting from draping 2D maps directly onto digital elevation models. Distortion is caused by perspective foreshortening and by the irregular shape of the terrain surface. Characters are compressed, expanded, skewed, occluded and misaligned, producing distorted text labels that are difficult or even impossible to read.
However, deformed type can also function as a visual clue indicating the shape of the terrain. When rendered in a perspective view, draped text labels traverse hills and valleys along curved lines. The curviness of these lines reflect the shape of the terrain. This paper draws inspiration from this observation encountered on 3D maps, and replicates this effect for standard 2D orthogonal maps. Type deformed in this way not only provides textual information, but also suggests the third dimension of the terrain.
A method is presented that bends text along a curved line following the terrain. The line is extracted from a digital elevation model. The amount and direction of bending can be controlled by a user-definable parameter. The more the label is bent, the closer it follows the undulations of the terrain and better portrays the shape of the terrain, but the more difficult it is to read.

Keywords: *Terrain mapping, label placement, lettering for areal features.*

1. INTRODUCTION: DISTORTED TYPE IN 3D MAPS

Many 3D maps show type with considerable distortion. The distortion prominently appears when standard 2D maps are draped directly onto the digital elevation model. The perspective projection deforms the characters, resulting in distorted text labels that are difficult or even impossible to read (**Fig. 1**).

The curved text labels in 3D maps reflect the shape of the terrain, as for example the label “Matterhorn” in **Fig. 1**, with the baseline highlighted in red. Despite its relatively large size, this label is hardly decipherable, because the individual glyphs are heavily distorted and the label is depicted upside down. Characters are more easily legible where the terrain surface is almost perpendicular to the line of sight (e.g. the initial “M”), and are illegible where the angle between the line of sight and the terrain differs considerably from 90 degrees (e.g. the “e”). This first type of distortion conveys information about the underlying terrain, but clearly hampers type legibility, and is therefore not further explored here. Indeed, this kind of distortion plagues every 3D map with mountainous terrain when text is draped directly onto the terrain.

There is, however, a second type of geometric distortion that bends the word as a whole. The word’s baseline – an imaginary horizontal line on which characters rest – is not straight, but seems to follow the terrain along a curve. The curved baseline is shown in red in **Fig. 1**, with the text label traversing the curved glacier.

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The mapping technique presented in this paper is based on the assumption that this second type of distortion encountered in 3D maps can be useful for improving the portrayal of terrain in 2D maps. It is assumed that deformed type can function as a visual clue indicating the shape of the terrain. This paper studies type deformation on standard 2D orthogonal maps to replicate this effect.

Type elements are placed on maps to label both visible and invisible features. Their location is often completely unrelated to relief. The technique presented here is therefore not an alternative to well-established methods for 2D terrain mapping, such as contour lining, hypsometric tinting or relief shading. Instead, type deformed in this way provides complementary hints that illustrate the shape of the terrain for relatively small areas only.

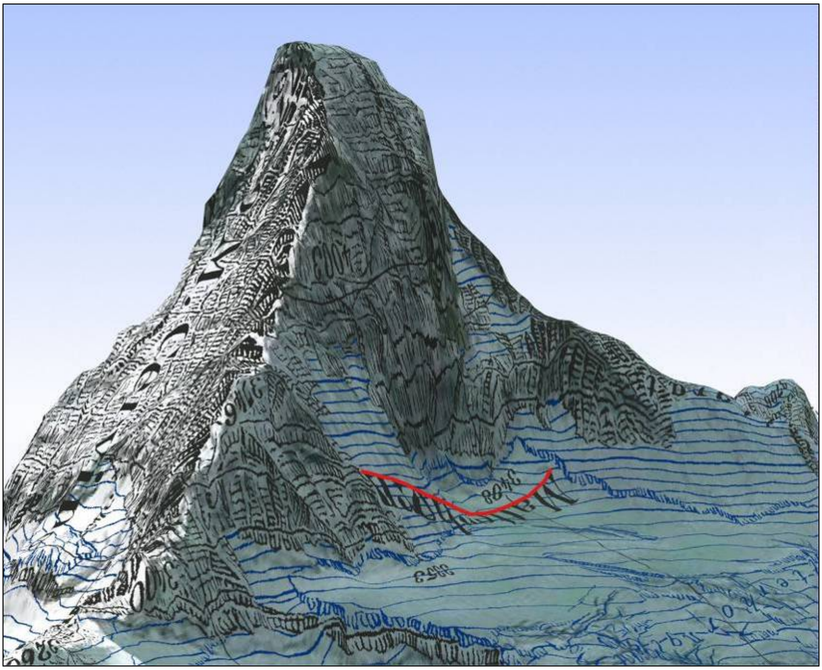

Fig. 1 Type draped on 3D maps is distorted and often illegible (from Häberling and Hurni, 2002)

2. A DIGITAL METHOD FOR BENDING TYPE IN 2D MAPS

A digital method for 2D maps was developed for positioning type along curved lines that follow the terrain. Lines are extracted from a digital elevation model. The line's curviness reflects the roughness of the terrain model, and can be controlled by a user-definable smoothing parameter. The more smoothing is applied to the terrain, the lesser the line is curved. **Fig. 2** and **3** show increasing convex and concave bending applied to the label "Suldtal". In the leftmost examples of both figures no bending is applied. In the middle examples, moderate convex and concave bending is used, whereas stronger bending is used in the rightmost examples. The more the baseline is bent, the closer the label follows the undulations of the terrain. Stronger and more irregular bending better reflects the variability of the terrain, but also generates text labels that are more difficult to read. Hence, the curviness of the baseline has to be adjusted to find a compromise between a curvier baseline with type that more strongly pronounces the third dimension of the terrain, and undistorted type that is easier to read, but does not provide any information about the third dimension of the terrain.

Fig. 2 Increasing convex bending of the label "Suldtal" in the center (map: swisstopo 1: 200,000)

Fig. 3 Increasing concave bending of the label "Suldtal" in the center (map: swisstopo 1: 200,000)

3. CONCLUSION

A digital method for bending type according to the modulation of a terrain is introduced. The type of bending (concave or convex), as well as the amount of bending can be adjusted. Further studies are required to assess the effectiveness and applicability of this graphical device for representing terrain on maps.

R E F E R E N C E S

Häberling C., Hurni L., (2002), *Mountain cartography: revival of a classic domain*, ISPRS Journal of Photogrammetry and Remote Sensing, 57/1-2, pp. 134–158.