Cartographic Means for the 3D Visualisation of Rural Landscape

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INTRODUCTION

The oblique views are a convenient technique for visualising three-dimensional (3D) geospatial information. However, their use in cartography has been occasional due to the laborious production process that differs significantly from the two-dimensional (2D) map production. Recently, 3D cartography has been contextually differentiated from the field of 3D computer graphics and the exploration on the new cartographic visualisation possibilities is intensive. In this paper oblique parallel projection, equilateral and equiangular grid and embedded landmarks are introduced as cartographic means to visualise rural terrain in 3D, and experimented with for the explorative purpose.

This research is part of the "Multi-publishing in supporting outdoor leisure activities" (MenoMaps) -project, financed by Tekes, Finnish Agency for Technology and Innovation. The aim of the project is to carry out research on the utilisation of multi-publishing for the purpose of outdoor leisure activities that have gained increasing popularity. The Finnish Geodetic Institute's (FGI) test environment for ubiquitous geospatial services is utilised for the project, located in the Nuuksio National Park in Southern Finland (Sarjakoski, 2007).

In the previous research on 3D cartography, it has been discussed about the nature and aims of the 3D maps, and experimented with the novel ways of visualisation. For example, Häberling (2008) developed cartographic design principles for 3D maps and Döllner (2007) produced computationally stylised cartographic 3D views.

METHODS

The cartography aims at providing the map reader with a map image on which to rely when forming a useful mental model of the geospatial reality. The following means are suggested to help in gaining this goal in 3D, particularly when a detailed depiction of the terrain surface is sought for.

Oblique parallel projection

The oblique parallel projection preserves the scales of the planes parallel to the image plane. This makes it favourable in cartography, the main target of which is approximately planar: the ground surface can be seen in a uniform scale and the differences in altitude create a strong impression of a relief. The oblique parallel projection is typically used along with directed lighting and thematic colouring to best depict the terrain forms.

Equilateral and equiangular grid

In an equilateral and equiangular grid, all the line segments have equal lengths and the angles between them are equal. The use of such a grid draped on the digital elevation model (DEM) can be very informative in 3D oblique views because it gives a clear reference to the metric characteristics of the used projection as well as those of the terrain.

Embedded landmarks

Landmarks are easily recognisable spatial objects that have a central place in constituting the mental images of spatial entities (Delikostidis, 2008). The current study assesses landmarks not only as an orientational and navigational aid, but also as purely graphical elements in 3D oblique views. It is proposed that landmarks facilitate the visual perception of a 3D view in order to explore the terrain.

RESULTS OF RENDERING EXPERIMENTS

An oblique parallel projection, equilateral and equiangular grid and 3D visualisations of building landmarks were combined incrementally into an experimental 3D rendering. The renderings were based on a detailed DEM (1 m resolution, 20 cm height accuracy) derived from the laser-scanned data of the FGI's test environment. The Natural Scene Designer 5.0 (NSD) software by Natural Graphics was used for 3D terrain rendering and Autodesk 3ds Max for rendering photorealistic 3D building models available from our previous research.

Firstly, suitable viewing and lighting parameters were sought for this oblique parallel view. The NSD fixes the horizontal viewing angle towards north by default. The other parameters were optimised through visually comparing multiple renderings with different values: the most suitable vertical viewing angle was found to be 45°, and horizontal and vertical lighting angles 135° and 30°, respectively. The horizontal lighting angle was found to be the most influential of these. For hypsographic colouring, the default values in NSD were used.

Secondly, the three equilateral and equiangular grids were draped on the DEM and their visual influence on the view as well as usefulness on metric estimations were assessed. The square grid was tested in two orientations: according to the cardinal points and rotated by 45˚. The triangular grid was evaluated as the most suitable because it
- explicitly defines the cardinal points in the image without redundant north-south lines
- provides a dense reference grid for estimating path distances along the segments.

Thirdly, separately rendered images on the 3D building models were embedded as landmarks into the view using image processing. Shadows were found to be important for integrating the models smoothly into the scene. Figure 1 shows the final oblique parallel view of the rendering process.

CONCLUSIONS AND FUTURE WORK

The present study produced a novel integration of rarely combined cartographic means in an experimental case of rural landscape. The resulting oblique parallel view shows an immersive relief of the elevations in the view whilst preserving the scale of the ground surface. The draped grid and hypsographic colouring provide the map reader with helpful cues for interpreting the geometry of the view.

The study leaves many topics open for research on cartographic oblique views, or 3D maps. All of the rendering results should be evaluated through user studies and the cartographic development of the presented means should be continued towards a more complete map image. The oblique parallel projection, particularly, should be further studied because of its potential in using it with conventional 2D cartographic techniques.
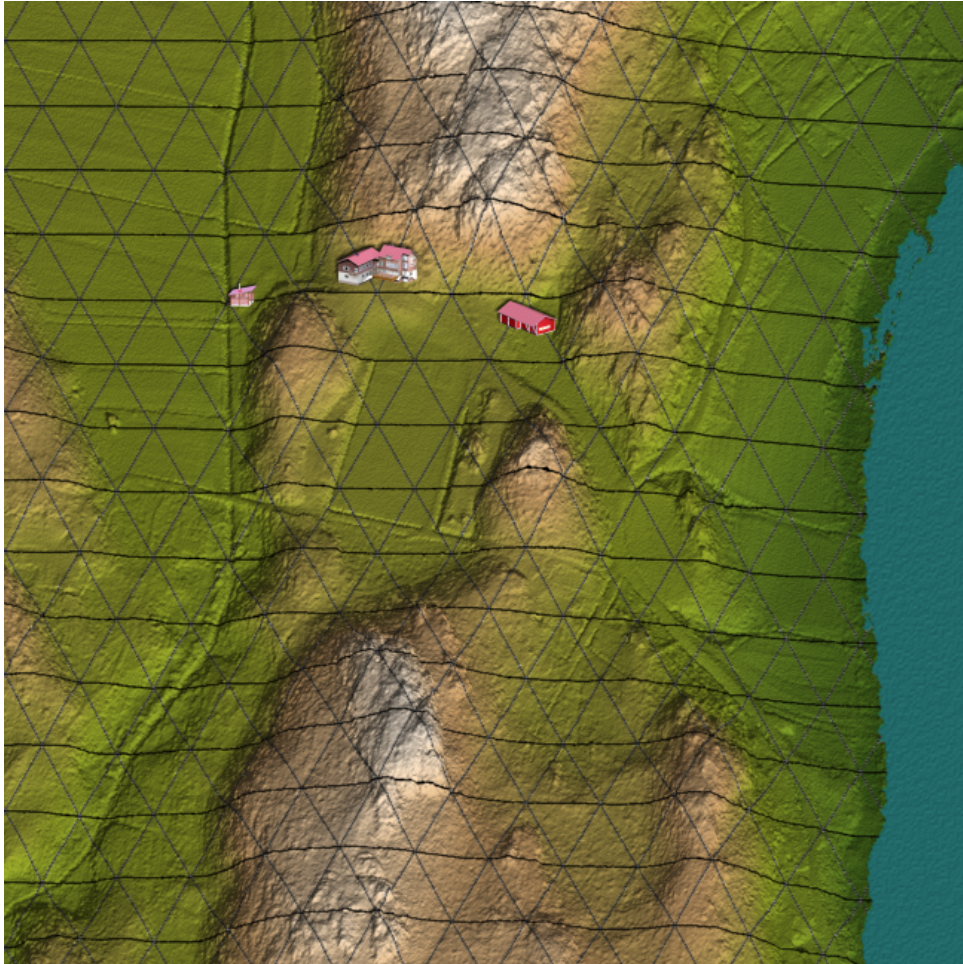
Figure 1: The resulting oblique parallel view with a 50 m triangular grid and 3D visualisations of building landmarks.

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