COMPUTER ANIMATION OF THE RETREAT OF TWO SMALL CIRQUE GLACIERS IN THE AUSTRIAN ALPS SINCE THE LITTLE ICE AGE ADVANCE OF 1850

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Abstract
The present video film describes the three-dimensional reconstruction of the retreat of two small cirque glaciers (Goessnitzkees and Hornkees, Hohe Tauern range, Austria) and, furthermore, it shows, as a highlight, the dynamic change of glaciation by means of computer animation.

1. Introduction

The content of this video film refers to a research project [1, 2] which has been carried out by the Institute of Geography and Regional Science, University of Graz, and the Institute of Geodesy, Graz University of Technology, with financial support from the Hohe Tauern National Park Service. On the basis of moraines (1850), old maps (1873, 1929) and metric aerial photographs (1954, 1969, 1974, 1983, 1992 and 1997) 9 different glacial stages were reconstructed. All relevant data of this time series are stored in a digital database. The spatio-temporal analysis of this database quantitatively revealed the course of deglaciation in respect to changes in area and volume. Furthermore, this digital database was also the data source for appropriate visualization of the glacier retreat. Since dynamic processes are difficult to show using standard cartographic means, e.g. thematic maps, a computer animation of the glacier retreat (glacier history) was implemented.

2. Visualization of the glacial stages in a dynamic mode

Computer animation is used to visualize dynamic processes. In contrast to computer simulation, where mathematical models provide numerical results, i.e. geometric properties are measurable, animation focuses on the graphical display of these results for visual perception. Therefore data accuracy is not of prime importance. Furthermore, the amount of data has to be limited in order to keep the data manageable and processing time low.

In the present study the dynamic change of glaciation has to be shown in a time-accelerator. All necessary data for this type of visualization is available through the digital database. The grid spacing of the DTMs has been increased to 15 m. Since only 9 glacial stages are available, irregularly distributed over the whole time period of 147 years, other intermediate glacial stages have to be interpolated from them, either based on a scientific glacier flow model or any other simplified geometric model. The first refers to computer simulation, whereas the second is adequate for the proposed task, especially because there was no theoretical glacier flow model available, at least for this type of small cirque glacier. In short, appropriate wireframe models of the surfaces can be generated on the basis of the DTMs. Any other "in between" glacial stage must be linearly interpolated in vertical direction in respect to the given time mark. The computation of this dynamic (glacier) model was accomplished by the interpolation module of the animation software (Maya of Alias | Wavefront). For the visualization the software computes images of the 3D model for the pre-defined time interval, i.e. the frame rate. The visualization does not only need the dynamic geometric model as input but also information on illumination and surface properties of the 3D object, both the glaciated and non-glaciated area. The animation software allows the selection of an appropriate light source, which can be positioned anywhere in the virtual space. The light source produces shades based on a Phong reflection model and, moreover, the relief of the surface casts shadows, which increase the visual perception of the 3D scene content. Surfaces are also associated with material properties, i.e. either procedural or mapped shaders. Glaciers are shown using procedural shaders, i.e. without texture in cyan color, and non-glaciated areas are mapped by means of a draped digital image, i.e. the orthophoto of 1997 with a spatial resolution of 1 m. Once all those settings have been defined, a virtual camera can be positioned in the scene. Finally, the rendering program calculates all frames within the specified time lapse as seen from the camera position. Each frame is stored in a single file, and subsequently transferred to a mass storage, i.e. a harddisk recorder (Pronto Video PV 24). The association with time in the animation is achieved visually by an inserted animated icon, i.e. a digital clock counting the years. In fact, an educational video film "glacier movie" (12:36) has been produced which covers the scope of this paper and, as a highlight, shows the retreat of both glaciers as a very realistic animation. The chosen monotonic sound track to the animation intensifies quite well the visual impression of the continuous glacier retreat. Short sequences of the computer animation can be downloaded from http://www.cis.tu-graz.ac.at/photo/viktor.kaufmann/. See also http://video.TUGraz.at/ for the complete video film.

3. References

[1] KAUFMANN, V. and PLÖSCH, R., Reconstruction and Visualization of the Retreat of two Small Cirque Glaciers in the Austrian Alps since 1850 – From Static Maps towards Dynamic Computer Animation, in: M. F. Buchroithner (ed.), High Mountain Cartography 2000, Kartographische Bausteine, Band 18, pages 239-253, Dresden 2000.

[2] KAUFMANN, V. and LIEB, G.K., Investigations on the retreat of two small cirque glaciers (Goessnitzkees and Hornkees) in the Austrian Alps, Europe. Proceedings of the 5th International Symposium on High Mountain Remote Sensing Cartographie (HMRSC-V), 24-25 August, 1998, Humboldt State University, Arcata, California, USA, in print.