Planning Hikes Virtually – How Useful are Realistic 3D Visualizations?

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The development of new technologies has made it possible to digitally visualize information in realistic three-dimensional forms. Realistic 3D visualizations may be interpreted more intuitively and distributing them over the Internet allows reaching a wide audience.
This paper presents a research project which aims to assess the usefulness of realistic 3D visualizations for the planning of hikes in the foothills of the Swiss Alps. With the help of web-based questionnaire surveys and interviews it is evaluated what people are able to achieve when using realistic 3D visualizations. The public is highly interested in the study and the new possibilities to plan hikes even though the technologies employed form some obstacles.
The evaluation of the feedback received indicates that people like 3D visualizations especially for tasks where the realistic representation gives them advantages over the map, such as getting an overview of an area. However, they find it difficult to extract precise information about a hike and additional information is demanded. The usefulness of digital 3D representations is also highly dependent on the people's motivation to work with it and the technical equipment needed.

INTRODUCTION

Whenever we plan a trip to an unknown region or on unknown routes we are confronted with the task of informing ourselves and with the need to read and interpret maps. This is especially true when going for a hike. As many people are struggling to efficiently read and interpret topographic maps, cartographers have started years ago to create representations that look similar to our daily conception of the environment like, for example, panoramic views. Such quite realistic visualizations may also contain abstract information, such as hiking routes, to help the users. The advent of new technologies has made it possible to create realistic 3D visualizations with added abstract information digitally and deliver them via the Internet. The users view them in a browser window and are able to navigate through the scene and give themselves an impression of the landscape. Such realistic 3D visualizations are nice to look at and may facilitate an easier familiarisation with an unknown region or hiking route.

This paper presents a study which explores the usefulness of web-based realistic 3D visualizations enhanced with abstract information for the planning of hikes in the foothills of the Swiss Alps. According to the statistics hiking is the most popular recreational activity of the Swiss (Kromer et al. 2001). It shall be discovered if realistic 3D visualizations provide enough functionality and information for planning a hike.

Context

Traditional maps encode the three-dimensional information about terrain features in two-dimensional variables but many map users have problems to efficiently read and interpret these. The development of new technologies has made available the tools to create and distribute new forms of maps, such as realistic 3D visualizations, in much simpler ways. Even though these new technologies open up many new opportunities they also start new discussions. One important topic is the degree of realism, or symbolism respectively, which is desirable in such new forms of representations. While both, realism and symbolism are defended by some researchers, the conclusion is that probably a combination of the advantages of both may work best and that the test for suitability is needed for any visualization. Another aspect is the usefulness of 3D visualizations. There is still research missing in this area, but it is generally agreed that the usefulness of visualization is dependent on the task and the goal that shall be achieved by using it, as well as on the users themselves.

Statement of the Problem

An EU Travel Study (Sloggett 1997 cited Almer and Stelzl 2002) shows that tourism regions and organisations are looking for new ways to promote their region and their main assets which are the great landscape and scenery and also the infrastructure available. The research presented in this paper explores the usefulness of realistic 3D visualizations

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for the planning of hikes in the foothills of the Swiss Alps. It therefore takes up a need and tests a new form of visualization in a specific context and with a specific task set. For the creation of the realistic 3D visualization virtual reality technologies from Geonova AG[1] are used. The region is restricted to the foothills of the Swiss Alps and the possible test persons are, basically, all people that are interested in hiking in this region. The task of planning a hike is defined according to the information needed: Information about the route and the region, calculation of the walking time including distances, height differences and a tour height profile. This information need is taken as guidelines for measuring the utility of 3D visualizations.

To compare the planning process using a realistic 3D visualization with the process using a LK25 map (Swiss National Maps 1:25'000 which are traditionally often used for these tasks) first the tasks performed during each step of the planning stage of a hike that yield the required information mentioned above need to be analysed.

Planning a Hike

The first step when planning a hike are the thoughts about a suitable type of hike. This is independent of the map but nevertheless very important. Different hikers have different requirements regarding, for example, the tracks, the views and the infrastructure. Then a hiker may want to get an overview of a hiking region for the decision if there might be suitable walks and if he or she wants to visit a specific region. Getting an overview includes studying maps and getting a feeling for the region and its terrain features. The next step is the selection of a route. Having some knowledge about a hiking region and its terrain features it should be possible to select a suitable route. Finally, the hike is planned in detail and after that a second time checked for suitability. The detail planning includes the estimation of how long it takes to walk a route, what are the distances and how steep, up or down hill, each section of the route is. These calculations can be done best by drawing a height profile along the selected route. Other important aspects include the type of the terrain (e.g. forest, pastures, and rocks), the views and possibly dangerous parts of the hike. These steps may lead to an adaptation of the originally selected route and the detail planning and the check for suitability has to be done again. Out of these considerations a questionnaire was designed that allowed to test the utility of the 3D visualization for the extraction of the information needed for the different steps of planning a hike.

STUDY AREA AND 3D SCENES

For the study an appropriate hiking region in the foothills of the Swiss Alps needs to be selected and visualized in a realistic 3D scene. The edge of a known but not famous hiking region in the canton Nidwalden in central Switzerland is selected as study area. Not everybody knows this region but it has good hiking infrastructure. The terrain is hilly but not mountainous and permits different hiking routes of varied difficulties. The main part of the area, ranging from about 430 to 2400 metres above sea level, lies below the tree line. The area is quite typical and similar hiking areas can be found in several regions of Switzerland. The selection of a rather small area of about 60 km2 ensures that the size of the 3D visualization is manageable.

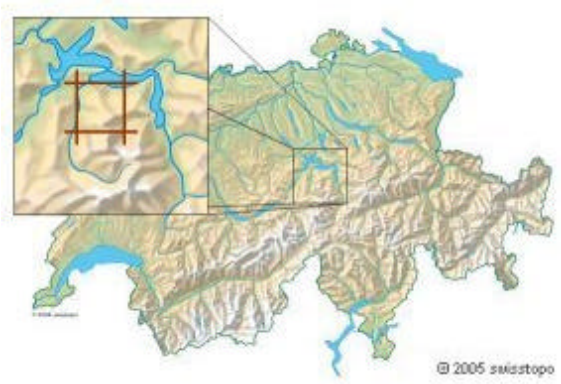

Figure 1: Study region

The realistic 3D visualizations are created with software tools of the company Geonova AG and made accessible over the Internet. The 3D scenes are composed of digital elevation data, ortho images and 2D vectors for the hiking routes. The data for the scenes are kindly provided by LIS Nidwalden AG[2]. The users are able to 'fly through' the landscape and freely navigate and explore it supported by some selected viewpoints and a predefined flight along the hiking route.

Scene Design

The design of a realistic 3D visualization is influenced by several factors, such as purpose, available data and software. So far, not many guidelines about how to create realistic 3D scenes with additional abstract content are available. Therefore, design rules from traditional cartography have to be adapted. Another important point is the available data. It is not sensible to plan a highly detailed and realistic visualization when the data needed for the realisation is not available. The use of available data also ensures that similar scenes can be recreated when they prove successful. There are many possibilities to collect and include additional information and functionality to help the users to make better use

[1] http://www.geonova.ch/

[2] http://www.lis-nw.ch/

of the visualization and give them more information about the region and the hikes, such as labels for restaurants, information about public transports and cable cars, and so on. However, it is decided to leave the 3D scene rather simple to be able to test how such plain scenes are able to help users and to find out what the information and functionality are that users are missing from the scenes. The scenes use a digital elevation model with a grid size of 25 metres and summer ortho images with a resolution of 0.5m. These data allows the creation of quite realistic 3D scenes by draping the ortho images over the elevation model. The impression of realism is mostly due to the rather high resolution of the ortho images allowing recognition of paths and buildings and many other details in land cover. There are no additional 3D objects like buildings or trees in the visualization. According to the tests done by Lange (1999) the terrain with the draped ortho images is the most important element for perceiving a virtual environment as realistic. In addition, one selected hiking route of medium difficulty is added to the 3D environment. It is available as 2D vector layer and can be coloured and overlaid in the scene. The use of one specific hiking route ensures that all participants of the study refer to the same route when answering the questions. To help the orientation, several labels with village, place and mountain names are inserted into the visualization. Following the customs in traditional perspective views (e.g. Figure 2: Traditional perspective view, Schatzalp/Davos (FSWE 2004)) also the heights of those places are labelled.

Figure 2: Traditional perspective view, Schatzalp / Davos (FSWE 2004)

The configuration of the surroundings of a virtual landscape and especially the lighting is very important. In the real world the sun provides the light and the water in the atmosphere models it (e.g. clouds, fog and haze). In a virtual environment special attention has to be given to the modelling of the atmosphere and the light as these elements greatly influence how the landscape looks and feels (Ervin and Hasbrouck 2001).

For the scenes in this study ambient light with no special direction for illumination is employed. This approach is chosen because the ortho images already contain object and landform shadows from the sunlight at the time of image capture. Adding additional shadows by the use of directed light in the scene would confuse the viewer. Most people go for a hike during summer time and in nice weather. Therefore, a light and summery atmosphere is created for the scenes. To achieve this, images from blue sky with some light clouds are selected for rendering the sky.

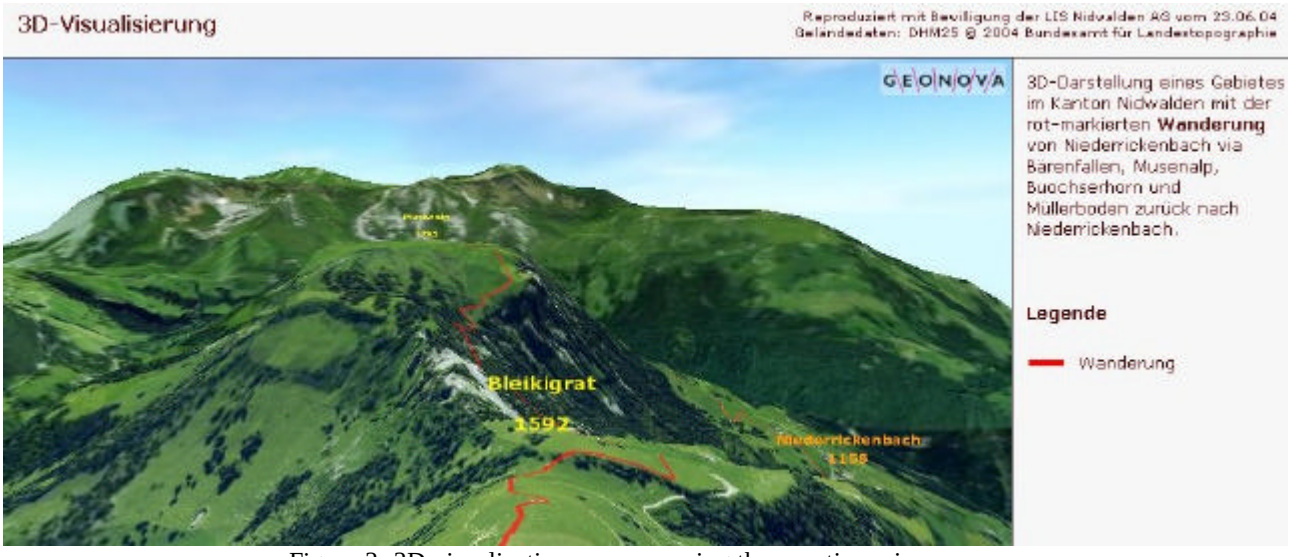

Figure 3: 3D visualization accompanying the questionnaire survey

DATA COLLECTION

Questionnaire

The tasks of planning a hike as defined above are translated into questions that allow to evaluate if a hike can be planned using a realistic 3D visualization. Basically, the realistic 3D visualization contains the same information as the LK25 map but in different forms. While on the map the third dimension is encoded in contour lines and spot heights,

this information is represented by a digital elevation model in the 3D scene. The information about land cover is represented by signatures on the map and through the ortho images in the 3D visualization. An exception is the amount of place names which is much higher in the LK25 map. Even though the scene and the map contain about the same information it is not suitable to exactly translate the tasks of the planning process into questions or tasks that should be performed in the 3D environment. The hike planning tasks, for example the creation of a height profile along the track, have traditionally been defined with the knowledge that they will be performed using a map. Thus, the tasks are analysed regarding their information content and translated into questions that ask for the discovery of the same information in the 3D visualization. For example, the height profile gives us information about steep sections or the highest and lowest points of a route what is information that can be asked to be found in the 3D visualization. In addition to this task specific questions a couple of questions asking about the users map reading skills and demographic information are added to the questionnaire.

The questionnaire is made available over the Internet together with the realistic 3D visualization. The sampling population for this study are basically all people interested in hiking in the foothills of the Swiss Alps. Thus, the population considered is large. By emailing different groups of people and asking them to inform further interested persons it is tried to reach persons in different age groups and from different backgrounds.

Interviews

The study also employs interviews to generate more qualitative statements surrounding the feelings and thoughts of people using realistic 3D visualizations. The use of a simple 3D visualization based on the digital elevation model and ortho images without much additional information for the questionnaire has originated from the idea of being able to figure out what is already possible to do with plain scenes. For the interviews a second scene is created that includes all hiking routes in that area and one proposed hiking tour marked in red. To inform the participants in more detail about this hiking tour, additional information, such as the height profile of the tour, the length and estimated duration of the hike, are added to the scene. The interviews allow finding out more about the aspects that might only be shortly noted in the questionnaire. It also allows following up on ideas and remarks and to ask further if someone gives unclear statements.

Abb. 4: 3D visualization accompanying the interviews

LIMITATIONS

The study does not research the navigational or representational aspects of realistic 3D visualizations for the planning of hikes. It is acknowledged that such aspects may influence the outcome of the study and it is tried to keep these influences to a minimum. The navigation is kept simple and is explained in some detail to the participants. Furthermore, the user interface of the viewer component G-Vista (Geonova AG) is already in use for many applications all over the world and has been adapted several times to ensure good usability.

Another aspect are the type of hikes looked at in this study. They are tours on marked hiking routes in the foothills of the Swiss Alps as they might be done by families, groups, and all other moderate hikers. These are also the types of tours that are most often promoted by the tourism boards of the respective regions. With a traditional map it is possible to plan also more serious tours, such as ski tours or alpine climbs. However, it is assumed that such attempts do need

more and exacter information as might be available from realistic 3D visualizations and are, therefore, not looked at in this study.

A further aspect is the limitations introduced by the technologies used. Several people hiking in the region studied might be older persons that do not own a personal computer and/or do not have access to the Internet. Thus, they are not able to benefit from such visualizations and are also excluded from this study. Additionally, the G-Vista ActiveX Component which is used to view the 3D scenes may not work on all computer configurations and does certainly not work on operating systems different from Microsoft Windows. The emission of the questionnaire via email and website may not exclude further participants as it is assumed that anybody having access to the Internet and being able to view the 3D scene will also have an email address and be able to fill in the questionnaire.

The results of the study could also be limited by the fact that many of the participants have so far been happy planning their hikes with traditional maps. Thus, some participants are likely to pose the question 'Why do we need 3D visualization at all?'. This notion might also be strengthened when technical problems are encountered.

RESULTS

Sample description

It is estimated that about 600 persons did know about the questionnaire. In the end, 99 participants filled in the questionnaire complete and further 68 persons have given other feedback. The feedback was mainly that people were not able to install the ActiveX Component and/or view the 3D visualization. The questionnaire has reached people from all age groups and about one fourth of all complete questionnaires were filled in by women. Interestingly, the author's experience with many people who have moderate or poor map reading skills is not reflected in the questionnaire data. Most participants have declared to have very good or good map reading skills. More than two thirds of the participants stated that they have come into contact with realistic 3D visualizations prior to this study. Another factor that might influence the answers to the questions about planning a hike with a realistic 3D visualization is the participant's knowledge about the study region. More than half of the participants state that they do not know the region, while slightly less know the region well or very well.

Findings

The analysis of the questionnaire survey and the interviews has shown that people are in general able to use realistic 3D visualizations for the task of planning a hike. However, this is also dependent of the amount of additional information in the visualization and the exact task that has to be performed. Getting an overview over a specific hiking region is, for example, a task that is helped greatly by the use of realistic 3D visualizations. More than half of the participants in the questionnaire survey would prefer to use realistic 3D visualizations for this task and not maps. They state their ability to conceive the landscape more intuitively and to get an idea of the region faster than with a map. Additionally, the research reveals that it is to some degree possible to detect roads and paths from a realistic 3D visualization. However, without marked routes in the 3D scene the participants do not feel confident enough to use it for the selection of routes. When using a 3D scene with all hiking routes represented in the interviews, all participants state that they would use it for the selection of a hiking route.

The extraction of exact height, walking time and distance information from realistic 3D visualizations is difficult. People are not confident in their findings. Tasks in the 3D scene that can be backed up with additional information such as height labels are solved quite well. This corresponds to the stated importance of the height labels in the 3D scene. Generally, measuring tools or more abstract height, time or distance information are demanded to make the 3D visualization usable for gathering precise information. A 3D scene offering time and distance information makes the interviewees state that the visualization is useful.

The study shows that people are not too confident interpreting the ortho images. For assessing the views the realistic 3D visualization certainly helps. However, the ability to navigate in the scene influences greatly the usefulness of the visualization for this task. The demand for additional, especially abstract, information in the scene is quite high. People are not able to satisfy their information needs with the realistic 3D visualization. However, people also state demands for information that neither can be found in the visualization nor on a traditional map. The demand for additional information might also be very high when using a map. But there the product is final and used as is and all further information is gathered from other sources. The new technology might have given an opportunity to voice demands in general. Nevertheless, about half of the participants feel sufficiently prepared for the hike after working with a 3D visualization. When given a 3D scene with a marked hike and additional time and distance information all interviewees state that they feel enough prepared to do the hiking tour.

Asking the participants what makes a realistic 3D visualization useful for the planning of hikes reveals that they think that 3D visualizations are nice to look at, represent the landscape as is – realistically - and allow to intuitively getting an idea of the area. The study shows that this is appreciated by the participants. They note that getting a fast overview and knowing about where a hike leads through is less complex than with a map. Most handicaps result from difficulties using the technology. Many persons were not able to install the needed software or had troubles or performance problems when viewing the 3D visualization. As stated above, a plain 3D scene does not allow the extraction of precise information from it and additional information is demanded. Other disadvantages are that the visualization cannot be taken into the field and that some people get cyber sick when navigating.

The analyses of the collected data with regard to different user groups show some differences especially for the groups subdivided by the time they spent answering the questionnaire. Thus, the usefulness of realistic 3D visualizations is certainly dependent on the time spent and the willingness of the users to familiarise themselves with the application. Some differences are also found between males and females, geomatic professionals and persons with other occupations, groups of persons that prepare different types of hikes and groups that had or had not prior contact with 3D visualizations. The questionnaire contains many statements noting that realistic 3D visualizations might be good for moderate or bad map readers. The comparison of the results with regard to different map reading skills shows that moderate map readers do have different preferences and abilities. The knowledge of the area does influence the usefulness of realistic 3D visualizations least.

CONCLUSION

The many filled in questionnaires, the other feedback and emails, the interviews and discussions led with interested persons; show that there is quite some interest in the use of new technologies for tasks that are traditionally carried out with maps. But the demands are high. The use of new technologies creates expectations for new functionality and possibilities. The study has shown that not everyone willing to use such technologies and to partake in the study is also able to install the needed software and view the 3D scene. Even though the technological developments of the last years have made it easier to create new forms of representations it cannot be assumed that everybody of the target audience owns a suitable personal computer and has the needed Internet connection available. The technical problems and requirements limit the usefulness of realistic 3D visualizations for the users.

The study contributes to the discussion about the needed degree of realism or symbolism respectively. Not many people are able to extract precise information from the realistic visualization and the ortho images. They are also not confident in doing so and the demand for more detailed or abstract information is high. For specific tasks, such as gathering detailed information about the hiking route, the realistic appearance of the 3D visualization is not enough although it contains basically the same information than a map. However, the statements concerning the intuitive comprehension of the landscape show that the realistic appearance certainly has its advantages over the map. Additionally, it is mentioned that extracting information from the ortho images is also a question of habituation. As well the use of the realistic 3D visualization and the navigation in it needs familiarisation. This is found from many statements and also shown by the fact that people spending more time navigating the scene and answering the questionnaire achieved significantly better results. Additionally, it needs to be considered that many of the participants of the study may so far have been content with planning their hikes using traditional maps. People like the new possibilities offered by a realistic 3D visualization but they are not immediately ready and willing to abandon the map. This is especially shown by the appreciative statements for the 3D visualization but on the contrary, also by some statements defending the map and the map reading skills as if it would have been proposed to dispose them.

For the questionnaire part of this study it was deliberately chosen to offer the participants a simple and plain 3D visualization with not much additional information content. This allowed seeing the people's abilities to work with such scenes and what they think is missing from the visualization. The G-Vista technologies would allow integrating many more functions, such as reading out heights and coordinate or measuring distances. The current research project Geo-Roaming (Nebiker 2004) of the Department of Geomatics Engineering of the Basel Institute of Technology and Management is working on a content management system that allows the easy integration of vast amounts of points of interests, labels, and other abstract information.

The usefulness of realistic 3D visualizations is dependent on the task, on the content and also, very importantly, on the users themselves. Realistic 3D visualizations might not replace the use of traditional maps for planning hikes at the moment. Nevertheless, they are good and expedient complements to them. The increasing use of and familiarisation with such visualizations might change the user's attitude in favour of realistic 3D visualizations.

RECOMMENDATIONS AND FURTHER RESEARCH

The findings of this study concerning the planning of hikes with realistic 3D visualizations may well be adapted for other applications. So could the presentation of tourism regions in general, the presentation of other types of tracks, such as bike, snow shoe or Nordic walking trails, paragliding information or any other information about outdoor activities benefit from them. Especially when realistic 3D visualizations are thought to replace or complement existing information means then careful consideration of the target audience, the user's expectations, their needs and current information means are sensible.

It might be interesting to research how people feel when actually going for hikes prepared with realistic 3D visualizations. The study shows that several participants think that the 3D scene looks twee and controllable, that one might underestimate a hike and that it might induce people to venture for badly prepared undertakings. Further research should also explore the use of PDA's or other devices for taking realistic 3D visualizations into the field.

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Susanne Bleisch, born 1976, studied Geomatics at the University of Applied Sciences in Muttenz, Switzerland. After finishing the studies in 1999 she went to New Zealand and worked a year as an Application Specialist and Quality Control for Trimble Navigation Ltd. Land Survey Projects and Systems. Back in Switzerland she returned to the Department of Geomatic Engineering at the Basel Institute of Technology and Management, University of Applied Sciences (FHBB). Susanne Bleisch is working as a scientific collaborator for the e-learning projects GITTA (Geographic Information Technology Training Alliance) and CartouCHe (Cartography for Swiss Higher Education) which are part of the Swiss Virtual Campus initiative, and the eLesson Markup Language eLML. From 2002 to 2004, she obtained a MSc degree in Geographic Information from City University London. She successfully finished the studies with the research project "Planning Hikes Virtually - Assessment of the Usefulness of Realistic 3D Visualizations".