REAL-TIME VISUALIZATION OF GEO-INFORMATION
FOCUSHING ON TOURISM APPLICATIONS

Alexander ALMER, Thomas SCHNABEL, Mathias SCHARDT and Harald STELZL
Joanneum Research, Institute of Digital Image Processing, Graz, Austria
Phone: ++43 316 876 1738; Fax: ++43 316 876 1720
alexander.almer@joanneum.at

KEY WORDS: Real-time visualization, landscape modelling, high-resolution remote sensing, tourism information

ABSTRACT:

In the public sector there exists a strong demand for innovative and user-friendly presentation of geo-information based on 3D-data visualization techniques. Professional GIS and remote sensing systems are generally designed as expert systems capable of handling large vector and raster data pools and making thus possible the creation of extensive calculations and analysis modules which are necessary for planning and decision tasks. In these expert systems, two-dimensional and occasionally only in some systems three-dimensional visualizations of raster and vector data are possible. The ongoing developments in different fields show the current importance and attractiveness of 3D-visualization technologies concerning the presentation of geo-information for scientists as well as for decision makers and for the public sector in general. In order to support different potential user groups, a web based solution for a real-time 3D-visualization of geo-information is of primary interest for different themes, regarding the aspects of being cost free for the customer and also for the end-user and of providing easily customizable navigation and design, standardized data interfaces and appropriate performance.

This paper will briefly describe results concerning landscape modelling and interactive real-time 3D-visualization by using high-resolution remote sensing data. The developments were realized within the EU-project REGEO (Multimedia Geo-Information for e-Communities in Rural Areas with Eco-Tourism) and in a subsequent commercial project. On the basis of the project REGEO requirements, the aimed scope of innovative 3D-data visualization was broadly tested and realized for different test regions based on Shockwave 3D-technologies, making thus possible a licence free solution. This contribution is aimed at describing the aspects of the generation of a landscape model, the processing of a natural texture based on high-resolution remote sensing data and the automated generation of the 3D-data model including the access to additional multimedia information for the interactive, real-time 3D presentation. A further important focus is to describe the performance potential of real-time 3D-visualizations for online systems. In addition, the realized prototype serves as an example for discussing and demonstrating interactive access to geo-information. Furthermore, the aspect of a dynamic real-time generation of 3D-data models from digital elevation models and textures will be presented and possibilities for the integration of geo-multimedia information will be highlighted. By the usage of standardized XML interfaces the application is capable of establishing an efficient linkage to the existing database systems. This makes possible a complete integration into existing online systems such as the geo-multimedia system REGEO.

1. INTRODUCTION

The development of theme-orientated information systems makes possible user-friendly online and offline applications as well as a multimedia interactive presentation of geo-data on the basis of 2D- and 3D-visualization technologies. This spatial access to information gives the user the opportunity to get access to very specific and personally relevant data. The application of interactive 3D-visualization in coordination with different relevant geo-oriented themes to be presented represents innovative possibilities of the space related presentation of geo-data. Tourism information is mostly geo-information and therefore tourism organizations are currently exploring visualization strategies which will maximize the promotional appeal of their regions and assets including unique landscape and scenery, natural environment and impressive cultural heritage. Within the framework of the project REGEO a geo-multimedia information system will be developed for rural regions with eco-tourism. REGEO’s overall purpose will be the presentation of the geographic component of tourism information in an easy way understandable for every user.

A main point within the framework of the project was the development of an interactive 3D-visualization module. The following requirements of the real-time 3D-visualization were discussed both within the project group and with end users:

- Interactive real-time 3D-visualization client
- Licence free for customers (e.g. tourism boards) and end-users
- Development of project specific viewer navigation
- Possibility of a specific viewer design for the project regions
- Dynamic landscape modelling (online generation)
- Acceptable performance for a web based 3D-real-time presentation of geo-information

Furthermore, the 3D-visualization module should also be made applicable to other online and offline applications on the basis of standardized data interfaces for the visualization of geo-data and with only moderate adaptation effort. A major requirement on the basis of the pre-inquiries was furthermore the aim to make the viewer navigation as user-friendly as possible so as to allow a fast and optimized access to 3D-information without the
necessity of any experience with e.g. 3D-game engines, a
knowledge children for instance have to a great extent.

The paper is organized as follows: In the second section a
system overview will be given. The data preparation will be
discussed as an important working step for the visualization of
geo-information in the third section. The following section
presents the results of the prototype developments realized in
the framework of the REGEO project and also in other projects
at the institute. The paper will finish with a short discussion of
the perspective for the presented real-time 3D-visualization
technology.

2. SYSTEM OVERVIEW

In order to design a visualization module which fulfils the
defined project requirements and which can also be integrated
into different web based solutions (e.g. web-GIS applications)
with an acceptable expenditure, a concept for a client-server
solution has to be defined. An overview about the general
concept for the web-based 3D-real-time visualization is shown
in the following figure.

![System Overview Diagram]

At the client side, the 3D-viewer is embedded into a HTML
page which will be shown in the web browser of the user’s
computer. On the server side, we have a web server (e.g.
Apache) with an installed PHP interpreter and a GIS (e.g. a
MySQL database with spatial extension). The tile raster images
will be stored on the webserver in a directory structure. The
communication between the client and the server is based on
HTTP. A PHP script on the web server handles the requests
from the client, accesses the GIS and sends back the required
data within a defined XML format. In this concept it doesn’t
matter if all the server components are at one place (centralized
system) or at different locations (distributed system).

According to the requirements of the project it is necessary to
pay special attention to software and hardware conditions for a
user-friendly realization of a real-time 3D-visualization. The
used 3D-technology and also the hardware requirements for the
prototype realization will be described in chapter 4. In general,
the following procedures have to be fulfilled in frame of geo-
data representation:
- Creation of a 3D-landscape model based on a pre-processed
digital elevation model and a true coloured landscape texture
- Dynamic landscape modelling (online generation)
- Integration of additional tourism related information (e.g.
hotels, restaurants, hiking and biking tours, sights) with the
aid of links to data bases including multimedia information.

3. DATA PREPARATION

The spatial character of information may be visualized in many
variations. Depending on the desired scale and basing on a
landscape model it is possible to visualize 3D-objects in a very
realistic way or even in a strongly generalized way and to show
information points symbolically. Digital elevation models and
remote sensing data in the appropriate scale form the basic
elements for 3D-landscape models. The following paragraphs
give a brief description of the preparation of these data.

3.1 Preparation of the digital elevation model

Digital elevation models play a vital role for a real-time 3D-
visualization. A digital elevation model (DEM), used for geo-
visualization applications, is mostly an 8-bit or 16-bit gray scale
image which is assigned a determined resolution and a
determined map projection with geodetic datum. The resolution
of the DEM depends on the desired scale of the 3D-model.
Based on the aimed scaling factor for the geo-visualization,
different DEM qualities can be distinguished:
- Very low resolution digital terrain model (DTM) with a
  resolution higher than 500m (e.g. USGS world DEM) for the
  visualization of a large region.
- Low resolution digital terrain model with a resolution higher
  than 90m (e.g. SRTM DEM) for the visualization of a
  tourism region.
- Medium resolution digital terrain model with a resolution
  higher than 10m (e.g. Federal Surveying DEM’s) for the
  visualization of a tourism region.
- High resolution digital terrain model with a resolution better
  than 10m for detailed visualization tasks.
- High resolution digital surface model (DSM) with a
  resolution better than 10m for detailed visualization including
  vegetation heights.

Based on the different qualities of a DTM and the aimed scaling
factor for the 3D-visualization, an improvement of the 3D-
model can be accomplished based on the integration of
additional height information for local areas and also on the
integration of 3D-objects to allow a high scale rendering of the
3D-model. Two possibilities can be distinguished:
- Medium to high resolution digital terrain model (DTM) and
classification results (vegetation classes) to make possible a
detailed vegetation height information for a local area.
Integration of buildings such as 3D-objects. This improvement will make possible high scale views of the 3D-model.
- High resolution digital terrain model (DTM) and single objects (vegetation and buildings), to allow a very high scale virtual flight and also detailed terrain views.

For real-time visualization, the amount of data has to be kept small to assure a good performance for the real-time navigation of the 3D-model. Therefore, for low scale visualization the transformation of the DEM to a lower resolution is one of the first pre-processing steps. For this conversion the bilinear resampling is very useful, since it possesses a slight smoothing effect whereby the formation of edges is avoided (Almer A., Stelzl H., 2002).

3.2 Geocoding of satellite image data

For the application of remote sensing data it is essential to geocode them into a determined reference geometry. This is accomplished by a parametric imaging model of a satellite sensor which is optimized with the aid of ground control points (Raggam et al., 1999). By using a digital elevation model the satellite image scenes are geocoded into the requested map geometry. To achieve an optimum visual depiction the bi-cubic convolution resampling is applied for the process of geocoding. The geometric accuracy of the geocoded image is examined by comparing with and superimposing the reference data, i.e. topographic maps and digital orthophotos.

To examine different resolutions for the 3D-visualization, satellite images of low and high resolution have been geocoded. To produce the highest possible resolution for color textures, panchromatic and multispectral images have been fused as it is described in the next chapter.

The following satellite images have been geocoded and used for the landscape visualization:

<table>
<thead>
<tr>
<th>Satellite Image</th>
<th>Resolution</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat TM 7 MS</td>
<td>30 m resolution, multispectral</td>
<td></td>
</tr>
<tr>
<td>Landsat TM 7 PAN</td>
<td>15 m resolution, panchromatic</td>
<td></td>
</tr>
<tr>
<td>QuickBird MS</td>
<td>2.4 m resolution, multispectral</td>
<td></td>
</tr>
<tr>
<td>QuickBird PAN</td>
<td>0.6 m resolution, panchromatic</td>
<td></td>
</tr>
</tbody>
</table>

In addition, panchromatic orthophotos have been used to enhance the resolution of Landsat images by means of data fusion.

3.3 Data fusion

Based on the geocoded data described in the last chapter, different data fusions have been generated to produce optimal coloured ortho-images. The following table describes the performed data fusions:

<table>
<thead>
<tr>
<th>Data Fusion Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat PAN - MS</td>
<td>Data fusion Landsat PAN - MS</td>
</tr>
<tr>
<td>Landsat - orthophotos</td>
<td>Data fusion Landsat – orthophotos</td>
</tr>
</tbody>
</table>

3.3.1 Data fusion Landsat PAN - MS

In the context of the work a multispectral Landsat TM scene (30 m resolution) was fused with a panchromatic Landsat TM 7 scene (15 m resolution). This data fusion was performed using the principle component transformation. The result (15 m resolution) was a useful texture for the low scaled 3D-visualization of a large region. To obtain higher resolution for high scale applications, other data were used as described in the next sub-chapters.

3.3.2 Data fusion Landsat – orthophotos

To obtain a higher resolution than possible with Landsat TM 7 a digital orthophoto mosaic (7.5 m resolution panchromatic) was used in order to produce true colour images at a resolution of 7.5 m. Precise geocoded remote sensing data are a precondition for such a data fusion, so as to receive an accurate fusion result. The applied method is based on the principal component transformation and supplies high resolution true colour images. In Figure 2 you can see the input data and the final result of the data fusion.

![Figure 2: Data fusion (7.5m) of Landsat TM (30 m) and orthophoto mosaic (7.5m)](image-url)
3.3.3 Data fusion QuickBird MS – QuickBird PAN
QuickBird images underwent a pan-sharpening process, where the panchromatic Quickbird image (60 cm resolution) is fused with the multi-spectral image (2.4 m resolution), leading to an enhanced multi-spectral QuickBird image of 60 cm resolution (see Figure 3). For the pan-sharpening process, the radiometric properties of QuickBird multi-spectral and panchromatic images are quite similar, since the pan-channel represents the same spectral range as the four individual multi-spectral channels. It was therefore straightforward to produce a high-quality multi-spectral image with 60 cm spatial resolution. The methodology used in this process is based on a Brovey transformation, where the pan-channel undergoes a histogram matching process relative to the first channel of the Brovey transformed image. This first channel is basically the sum of all multi-spectral channels and shows, therefore, a high correlation with the pan-channel. The result of the histogram-matching then replaces the first channel of the Brovey transformed image and an inverse Brovey transformation is applied to obtain the final result of the pan-sharpening process (see Figure 3).

3.3.4 Comparison of resolutions
To show the range of different resolutions used in this work, subsets of the different raster data are shown in Figure 4.

Figure 3: Pan-sharpened QuickBird ortho-image (0.6m) produced from panchromatic QuickBird image (0.6m) and multi-spectral QuickBird image (2.4m)

Figure 4: Comparison of different resolutions
3.4 Landscape modelling

The basic data form the starting point for the creation of a landscape model with a realistic texture. This modelling process may be carried out as a pre-processing or take place dynamically during its run time. In order to create a model by means of pre-processing 3DS Max and Maya may be used among others. Such modellings however suffer restrictions concerning exportability of geometries or settings in relation to texture and mapping. Thus, only tests show in many cases which settings produce optimum results.

By way of contrast the 3D-scene may as well be created in real-time, avoiding hereby costs and initial periods. In case of a real-time creation of the landscape model the following points are to be kept in mind respectively carried out:

- Hardware requirements for the target system (the user’s PC system)
- Loading of the 8Bit DEM
- Derivation of a wireframe model from a DEM (raster elevation model)
- Dynamic loading of textures
- Possibility of visualization of large amounts of data by means of tiling

For the visualization of a region, as this is the case with the realization in the project REGEO, the above described limitations resulting from the graphic hardware require a division (tiling) of the 8-bit DEM and the texture. Thus, the user has the possibility to choose which section he wants to see and how detailed he wishes to view a region. For this, only the visible tiles are used for the generation of the 3D-view. As the user moves within the virtual world or when he leaves the currently visible area, the then required DEM and texture blocks are reloaded. The textures may also be loaded successively, making thus possible a faster building-up of the virtual world. This is particularly relevant for online solutions, taking into account users of slower Internet connections. In addition and depending on the currently viewed section and the distance between the camera and the surface, it is possible, to show different Levels of Detail (LODs) in a determined area. Thus, within the visible part of the landscape a highly detailed texture is shown, whereas in areas invisible at the moment a better texture is being reloaded. Figure 5 shows an area, where some of the textures to be displayed remain to be loaded and different levels of quality are intermingled.

3.4.1 Derivation of a wireframe model from a DEM

An 8-bit DEM forms the basis for the real-time visualization of a 3D-landscape model. From this a regular wireframe with the according elevation information is created. A decisive point for the extension of the wireframe is the gridsize of the used DEMs. The gray tones of the respective pixels represent herein an indicator for the elevation of the respective vertices. Figure 6 shows an example for the visualization of an 8-bit gray scale DEM and Figure 7 of a DEM as a finished wireframe.

Figure 6: 8 Bit gray scale DEM

Figure 7: Wireframe model

3.4.2 Loading of the 8-bit DEM

The DEM is loaded into the memory dynamically and offers thus the possibility of showing very different landscapes without the necessity of a larger main file. As it was mentioned above, it is important to pay attention to the number of pixels of the DEM, because a higher number of pixels on the one hand makes possible the visualization of a larger region and a detailed modelling, but on the other hand the demands on the graphic card increase considerably.

3.4.3 Dynamic loading of textures

The according texture is mapped onto the finished wireframe. This makes possible not only the displaying of a particular model, but also to allow the user to choose a part on a map and get a 3D-visualization of it. Thus, the presentation of the information is highly advantageous in comparison with the hitherto pre-generated landscape models. Nevertheless, it is important to pay attention to the hardware requirements necessary for this applicability.
4. PROTOTYPE APPLICATION

4.1 3D Technology

To allow an efficient development of the necessary procedures which are defined in chapter two, and also to fulfill the defined project requirements it was necessary to choose the appropriate 3D software technology for the realization in advance. For the evaluation of different technologies like e.g. Java3D, VRML, and X3D we decided in favour of Shockwave3D. The possibilities and the performance accomplished with this technology within other realizations distinguish Shockwave3D as the optimum solution offering advantages such as easy programming and the integration of data, further the compatibility with Mac and PC as well as support for DirectX and OpenGL. In addition, the development of an online and offline version is identical except for the access to data bases and consequently lower development costs arise concerning porting between online and offline systems.

To show the 3D-viewer on the client, the user needs to have the Macromedia Shockwave Plug-in installed. As it is a common plug-in and it is also used for other applications it can be presumed that it is already installed. The size of the plug-in is about 2.5 megabytes (Schnabel et al., 2003).

4.2 Hardware requirements for the target system

For the creation of landscape models it is essential to make sure the memory of the graphic card is large enough to store the uncompressed texture in the memory. Concerning the choice of the appropriate DEM resolution it is necessary to pay attention to the fact that a higher number of pixels produces a higher number of triangles. In combination with a high number of triangles and non-existing 3D-acceleration this may result in a lower hardware performance. Taking into account the assumed graphic card of the target system and its renderer it is vital to find out the appropriate resolutions for an optimum visualization according to chapter 5 (Gross, 2001). We developed this prototype by using an ATI RADEON 9700 with 128MB Video Ram. Tests with different graphic cards with 32 and also 64 MB Video Ram were carried out showing satisfactory results concerning the expansion of the landscape and the performance of the 3D-visualization.

4.3 Usability

Within the frame of planning and realization of the prototype usability tests were carried out. The results of these tests yielded a qualitative and quantitative performance evaluation of different potential input devices (mouse, keyboard, joystick, webcam, etc.). Thus, it could be shown, how the tested people handle this form of information access and to what extent the aim of a user-friendly usage of the application could be realized. For this series of tests a group of 15 people was selected representing the potential system users, consisting of eight male (53%) and seven female (47%) persons. Based on the results, user interface and functionality of the application were developed and adapted.

4.4 LOD

The “Level of Detail” is important when the application allows for the presentation of landscapes in different scales. A simple implementation of the LOD is to switch the resolution of the DEM and the texture depending on the distance between the camera and the landscape. When the user for instance watches the landscape from a height of 10km, he will not see every single house, tree or rock. Therefore, we can use a DEM and a texture with a higher grid size. The lower the height of the camera, the more details have to be visualized. If we go down to about 200 meters to see a representation of the landscape at a high resolution (e.g. 1-2 meters/pixel), also the height of the trees in a forest have to be shown. To do that we can either use a high resolution DSM or we can show forests by the usage of a DTM and an extra 3D-model for the vegetation areas. An overview of the different scales and the used DEMs is given in chapter 3.1.

4.5 Area classification

As indicated in chapter 4.4 we can show different areas with different objects. This is important in order to be able to present classification results. For example when the classification result of a forest is to be shown, the application may show different tree classes in different colours and/or different model heights. These areas will be shown as polygonal hulls which are either textured or simply coloured.

4.6 Visualization of additional information

Apart from the visual impression of mere landscape visualization the user are offered additional information levels. In order to visualize this information, symbols may be faded in and out in a 3D-environment what users already know from existing 2D-visualizations. Thus, symbols may also be generated and placed during the run time, existing different methods of the visualization. Either 2D-images of the symbols are superimposed over the virtual world giving thus the impression of a 3D-visualization, or “real” 3D-objects are generated. By means of these symbols the user may receive brief information with the aid of a mouse-over effect or by simply clicking the symbol. Thus, he may proceed directly to a linked site or a section, where he may receive detailed information about the chosen point. The visualization of additional information however is not limited to symbols. In order to give the user an even more realistic impression of his environment additional objects like buildings, towers, etc. may be placed on the landscape surface. For a more detailed visualization of an area either standardized buildings may be used or even detached objects of particular interest may be modelled in detail. In addition, also the visualization of linear elements like e. g. hiking routes, biking trails etc. is projected, with the option of integrating them as well into the virtual landscape as 3D-objects. Furthermore, also landscape changes may be shown. During the run time the landscapes may be modified very performantly in order to give the observer an impressive insight into temporary changes. Texture overlays offer a coloured visualization of changes, thus, as example flood-threatened regions or such with high traffic density can be marked. Such methods are not limited to tourism but may on the contrary be applied for presentations of real estate, landscape planning, real-time simulations of changes or the visualization of historical data among many other things.

In order to gather the required data of the additional objects it was necessary to access the GIS data base on the server. This was achieved by requesting data from the server application. To request information and to transport the data to the client we
used HTTP. The data were transferred within a defined XML data structure. The usage of this technology makes possible a high flexibility and easy adjustability concerning the integration into different existing systems.

4.7 Virtual Flights

In addition, to visualize additional objects it is also possible to perform virtual flights within the created 3D-world. Therefore, we had to create a flight path, which was predefined or created based on a line element (e.g. flights over hiking tours, etc.). When we create the path along a line, we reduce the amount of key points and use the result as the flight path. The camera flies at either a constant height or relative to the terrain.

4.8 Realization

The following two figures show the developed 3D-viewer and the user interface for the prototype. As described in chapter one the usability was an important goal in the development of the design. It allows the user to explore easily the virtual 3D-landscape. Next to the navigation, the user’s current position and viewing direction are always shown with an arrow in the overview map. The wind rose as well shows the general orientation of the 3D-perspective map view.

Figure 8: Real-time 3D-viewer for interactive navigation using a texture with 7.5 m resolution

Figure 9: 3D-viewer with a 0.6m Quickbird texture

Figure 10: Integration of the 3D-viewer into Geokonzept’s CSA

4.9 Restrictions and things to think about

In the beginning, a wireframe model was created from the digital landscape model, which was cut out and resampled in advance, making necessary the achievement of some conditions at the time of preparation. In order to be used in Macromedia Director (Gross, 2001) the DEM had to be reduced to 8 bit. Digital landscape models are often available as 16 bit images and contain much more different values than can be shown in the end. For the here used scale the 256 gradations between the highest and the lowest point of the region are sufficient.

Another important point concerning the preparation of digital landscape models is its number of pixels. The larger the size of the landscape model, the larger the number of triangles necessary for the generation of the wireframe. Using modern graphic cards capable of using hardware related 3D-acceleration by means of DirectX or OpenGL the number of triangles may amount to 100,000 and even more, without the likelihood of performance losses. Without the necessary hardware supported 3D-acceleration the visualization performance is fairly low depending at the same time however on the speed of the used processor. With 100,000 triangles a rather large area can be shown. This applies particularly for a camera which is far away from the surface. As described in chapter 4.4 we use a level of detail, depending on the distance between the camera and the model. If zooming in, the viewed area will be smaller. Based on this a more detailed DEM is loaded, which has the same amount of triangles but visualizes the smaller area in a much more detailed way. The viewer as well switches to a more detailed texture, when the camera approaches the surface.

The texture used here with its resolution from 15m/pixel (lowest) to 0.6m/pixel (highest) is perfectly adequate for this purpose. In reference to the factors for the selection of the grid space and thus the number of triangles it is essential to take into account the target system, the landscape model, the accuracy of the texture and the scale in which the landscape will be presented. For a terrain, for which the texture shows a very high
resolution or for a landscape showing very cragged rocks and peaks more triangles are required, because in these cases the danger exists, that at worst a peak might be shown with a rounded shape. In addition, it is crucial to pay attention to the memory of the graphic card as this memory is a basic criterion for the size of the used texture. It is possible to use textures of 2048x2048 pixels and more in Shockwave3D, depending on the graphic card. It is necessary to bear in mind that this texture limit applies for a single texture. Using several models simultaneously makes possible to show the entire landscape with a very high resolution, as every model can be assigned its own texture. As mentioned above this is limited by the memory of the graphic card and for online-applications the limiting factor remains the bandwidth available to the user. For the calculation of the memory requirements it is necessary to assume that the uncompressed image has to be available in the memory of the graphic card. At a resolution of 2048x2048 pixels this equals approx. 12.3 MB. This means that nine texture blocks with such a resolution can be shown at once by using a 128 MB graphic card. When the user moves away, the old, not needed texture blocks will be erased from the video card memory and the new textures will be loaded. When JPEG is compressed, one texture equals approx. 1.6 MB for the transfer via the network.

5. PERSPECTIVES

Particularly in tourism the Internet user is faced with large amounts of information. Today, the visualization of geo-information is still being realized very differently depending on the theme. Many existing information systems show high limitations concerning the multimedia presentation of spatial information. For online and offline applications a real-time 3D-visualization of geo-information offers particularly in tourism an innovative possibility for the presentation of certain themes, provided we take into account a user-friendly graphic user-interface in order to guarantee maximum usability (Almer et al., 2002).

For the visualization of tourism information in Alpine regions, but even in extremely sensitive regions such as national parks, the interactive 3D-visualization is of added value to the tourist and provides a well-directed access to information. By means of appropriate interfaces it is possible to get access to existing data, so as to accomplish a complete 3D-presentation of a region in a realistic way. User-related presentation in connection with an innovative 3D-visualization of geo-information will play a crucial role in the acceptance of information services in tourism. Within the framework of the project REGEO these 3D-technologies are realized in all test regions of the four member states. Alongside the previously mentioned Czech and Austrian regions (“NP Podyji” and “NP Thayatal” / “Tourism board Retzerland”) also the Polish “Kozienice Landscape Park” and the German “Nature Park Thuringian Forest” will be presented with real-time 3D-technologies in an online and offline version.

6. REFERENCES


Data: ISPRS-Technical Commission IV/6, ISPRS Congress Ottowa, 8th-12th July 2002


