3D-VISUALISATION OF LEISURE & TOURISM INFORMATION BASED ON REMOTE SENSING DATA

Alexander ALMER, Alexander K. NISCHELWITZER
Joanneum Research, Institute of Digital Image Processing, Graz, Austria
alexander.almer@joanneum.ac.at

Technical Commission V-5

KEY WORDS: Remote Sensing, animation, data fusion, image registration, visualisation, virtual reality

ABSTRACT

Tourist centres throughout the Alps are currently exploring the potential of new presentation strategies that will maximise the promotional appeal of their region and its main assets, which include a unique landscape and scenery, an impressive cultural heritage, and a wide range of sports facilities and other tourist amenities. The EU Travel Study carried out by Sloggett (1997) revealed that major travel and tourist companies and organisations take an increasing interest in satellite technology, and in the development of a Travel, Leisure and Tourism Information Service which will allow potential clients to pay an on-line visit to their chosen holiday resort. The kind of innovative Information Service they envisage will provide information on the resort and the region, offer entertainment and also allow business transactions. It will integrate satellite images, GPS data, GIS information, terrestrial images and will also include tourist information as well as offering multimedia and 3D-visualization technologies and interactive navigation.
This paper will briefly discuss the current situation in the leisure and tourism industry as regards currently available modes of information presentation for specific target groups. It will then discuss proposals for a novel interactive multimedia information system, focussing on the various components of such a system. The system will integrate satellite images, GPS data, GIS information and other information on leisure activities and tourist facilities. Aerial and satellite images will be used to implement the visualisation of the tourist region for multimedia CD ROMs (digital brochure) and display on the internet.

1 INTRODUCTION

In a world where industry and business are becoming increasingly globalised and have resulted in the creation of *Total Digital Networks* (TDN), there is a growing need for effective systems that can organise, prepare and transfer data and so guarantee that every citizen has access to all the information he or she may require. A large number of online services are already available (see Figure 1). However, there is an increasing demand for improved data transfer capabilities as well as for better customization which will tailor information systems to the needs of a specific group of customers and use different output media.

Information	**Transaction**	**Entertainment**
• News	• E-commerce	• Online games
• Events	• Payment systems	• Chat
• Advertising	• Online shopping	• Music
• Weather, travel	• Ticket reservations	• Lotteries
• Sport and leisure	• Online booking	• Video
• Hotels / campsites		• Live Cams

Figure 1: Markets for on-line services

In 1996, the total market for multi-media developments was worth 2,400 billion DM in the G7 countries. By 2001 it is expected to reach 3,900 billion DM. This is equivalent to an annual growth rate of 10 per cent. According to Allen and Hamilton (1998), the single biggest contributor to this growth is likely to be *content* which will account for around 38

per cent of the total turnover in 2001. These figures underline the need for an effective system which can adequately organise, manage, automatically process and display the huge amounts of data that will be available.

An increasingly important target group for the tourist industry in alpine regions are the mountain bikers. A survey carried out in 1999 by the lifestyle magazine Bike amongst its readers showed that an above-average number of mountain bikers (35 per cent) regularly uses the internet and that they are generally prepared to try out and experiment with new technologies. The mountain bikers therefore represent an optimum starting point for target group marketing, which involves the development of highly specific marketing strategies for a clearly defined target group (Delius Klasing Marktstudie, 1999).

2 MULTIMEDIA PRESENTATION OF LEISURE & TOURISM INFORMATION

Tourist authorities worldwide are keenly interested in new multimedia technologies, including electronic 3D maps and films, that will allow them to highlight the leisure activities and sports facilities available to specific target groups in their area. Such technologies, they hope, will give potential customers a more realistic picture of the region, bring to the fore its unique attractions and also permit interactivity. Users will be able to specify their wishes and needs, and tourist managers will be able to respond more quickly and present their suggestions in a more attractive format. When recommending mountain-bike and hiking trails, cross-country skiing tracks and downhill pistes, managers will be able to tailor them to suit individual customers' needs. It is expected that multimedia presentation will especially appeal to younger target groups.

Publishers of tour guides and maps similarly have expressed a strong interested in the new technologies. Electronic media can store not only more but also more accurate information, and they permit interactivity, which printed media are unable to provide. 3D maps and virtual flights on CD-ROM are seen by the publishers as an opportunity to upgrade and expand their product range. And they hope that innovative presentation techniques will both benefit their business and also enhance their image.

On the basis of the tourism pamphlets existing in a great number, mountain-bike tour guides, etc. general processing measures of a digital, multimedia preparation of leisure and tourism information can be defined as follows:

- Data visualisation for larger regions using medium and high resolution satellite data, digital maps, digital elevation models (DEMs), etc.
- Visualisation of smaller localised areas using high resolution satellite data, digital maps, DEMs, aerial images, terrestrial images, models of objects, etc.
- Detailed visualisation – visualisation of town districts, individual buildings and views of rooms and larger internal spaces (virtual walk through a town; virtual visit to museums; etc.)

The basic principles outlined above suggest that an information system that can fulfill the requirements of the travel, leisure and tourism industry will need to integrate the following components:

- Tourist space maps, 3D images/maps
- Virtual flights including animated GIS information
- 3D visualisation and interactive navigation – VRML (Virtual Reality Modeling Language) modelling
- Panoramic views and animated images
- Links between image data providing geographic information and information touching on tourist facilities and leisure activities, which is essentially content oriented.

The development of an interactive, multimedia information service which comprises all the components set out above will include the following tasks:

- Geometric modelling of satellite images to integrate all data for the tourism information system in a geographically oriented data system
- Fusion of remote sensing data of different spatial and spectral resolution (aerial images, Landsat TM, SPOT and IRS-1C images, etc.)
- GPS measurements to define geographic coordinates about mountain bike trails, hikes and ski tours and also about the relevant tourism infrastructure
- Definition of a geographically and thematically oriented data structure for complex tourism and leisure information
- Creation of the virtual flights including animated GIS information
- VRML modelling for the interactive navigation of 3D models including animated GIS information and links to essential information
- Generation of interactive 360-degree panoramic views (Quicktime Virtual Reality Objects and Panoramas)

- Programming and data optimization for a CD-ROM based multimedia presentation of the tourism and leisure information system
- Programming and data optimization for an internet presentation of the tourism and leisure information system
- Data optimization for the generation of an analogue brochure based on the data available in the digital tourism and leisure information system

3 REALISATION OF A INFO SYSTEM FOR MOUNTAINBIKER

As part of a project commissioned by Delius Klasing Publishers, Joanneum Research developed an interactive multimedia CD ROM featuring recommended mountain bike trails in the Trentino region. Drawing on available satellite data and aerial photographs, the first year involved compiling information on 33 recommended trails around Lake Garda and in the Pasubio area and preparing the data for multimedia presentation. The CD ROM includes satellite images (see Figure 2) of each route and comprehensive details including information about signposts, roadbooks (see Figure 4), and over 170 photographs.

The following sections set out the types of content which successful interactive multimedia CD ROMs need to provide.

3D maps of trails
The use of 3D maps represents a novel form of information presentation. They contain general tourist information as well as specific details about mountain bike and hiking trails which can be quickly accessed and is easy to process, permits interactivity and guarantees up-to-dateness. Compared with conventional printed maps, electronic 3D maps have two major advantages. Firstly, they provide ready information not only about distances but also about gradients along the chosen route; and secondly, 3D maps permit users to view the area from a variety of angles giving them a comprehensive overview of the target region.

Virtual flight in 3D space
3D maps can also be animated to produce moving images and simulate a virtual flight across the region where the user plans to go for a mountain-bike ride. The animation simulates a flight in a helicopter and gives the users a very realistic picture of the difficulties that may confront them along the route.

Combining spatial and content information
An important advantage of digital presentation media is that they can combine and fuse different layers of data whilst at the same time ensuring maximum user-friendliness and ease of access. Most users are interested not only in mountain bike and hiking routes but also in other information that may be relevant to tourists, including the main sights, the availability of leisure activities, hotels, guesthouses, restaurants etc along the chosen route. To integrate all these different types of data into a single CD ROM, an information system is needed that can support the spatial structure of tourist information.

3D maps have the advantage that they permit the mapping out of a specific routes for different target groups. This feature is of particular relevance to mountain bikers, cyclists, hikers and skiers, who all urgently need the kind of detailed information that 3D maps provide. By combining information about geographical features with other tourist data it is possible to generate an exact and maximally detailed description of the planned hiking or cycle tour.

3.1 Description of data

In order to include comprehensive information that will allow mountain bikers, hikers and skiers to plan their route, the following data were integrated into the system:

- Satellite data (Landsat TM), digital aerial images
- Digital elevation model (DEM)
- Collection of tour on GPS-basis (incl. elevation profiles)
- Descriptions of the tours (roadbooks and characteristic features)
- Additional tourist information

In order to ensure the successful fusion of different data, the data have to be geometrically preprocessed. All image and vector data and tourist information were therefore transferred to the same standardised cartographic system. The reference data used were digital orthophotos. The first stage involved creating a mosaic (2.5 m resolution) from the over fifty orthophotos.

High-precision geometric treatment of the Landsat TM satellite image requires precise ground control points (GCPs), which were determined on the basis of the orthophoto mosaic and the Landsat TM image. The GCPs were used to

determine sensor-specific mapping parameters and, to optimise these parameters in a least-squares parameter adjustment (Almer et al., 1991). A parametric geocoding procedure including a DEM as implemtented in the RSG (Remote Sensing Software Package Graz) software system was used to generate a geocoded Landsat TM image (Raggam et al., 1991). The RMS (root mean square) of the geometric accuracy after the least-squares parameter adjustment is in the sub-pixel range for the Landsat TM image.

During the second stage, the geocoded Landsat TM image with a pixel resolution of 30 m was combined with the panchromatic aerial orthophoto mosaic to produce a high resolution digital image of the region (see Figure 2).

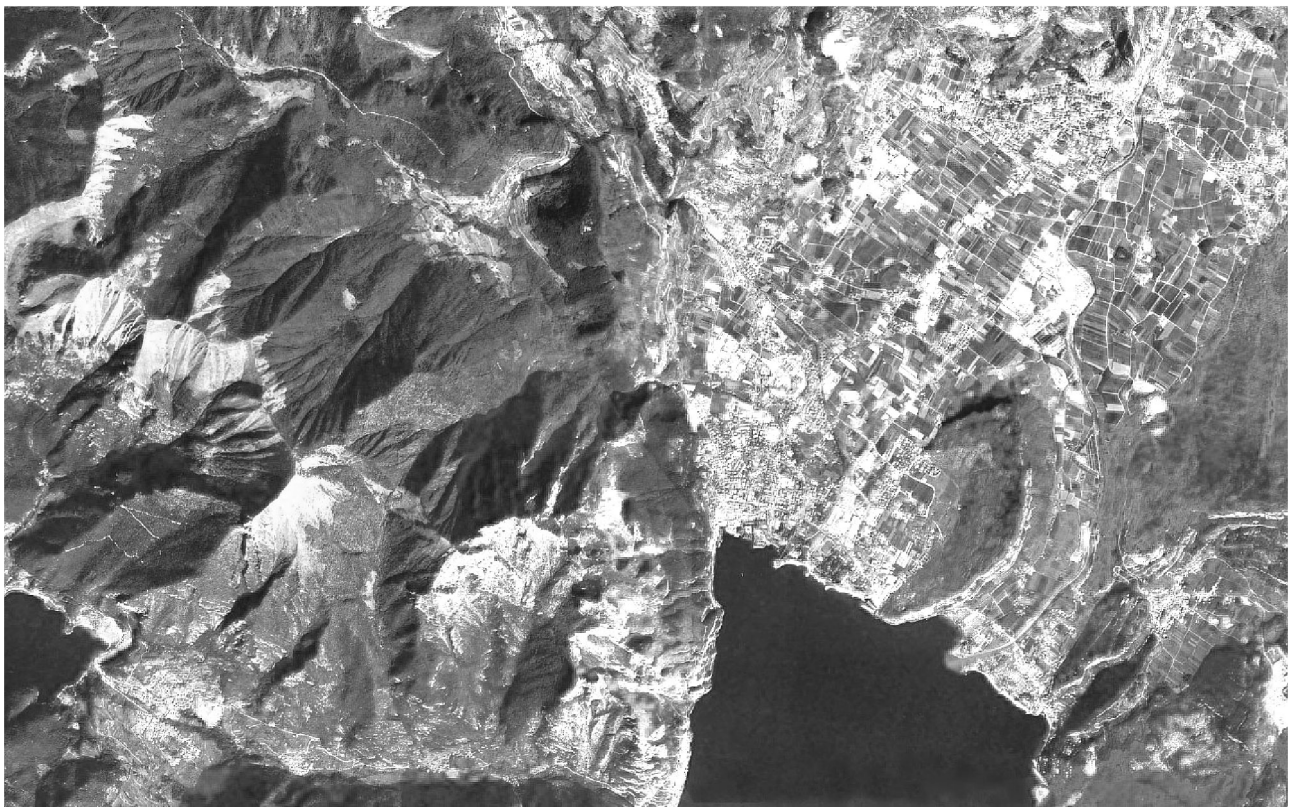

Figure 2: Section of a high resolution image combining Landsat TM and aerial image data

The maximum resolution of these combined images was 7.5 m. Lower resolution imagery was generally used for regional overviews and the virtual flights. The DEM which was available to us had a grid width of 40 m. However, for the 3D representations and virtual flights grid widths of between 50 and 100 m proved sufficient.

By combining high resolution aerial photographs with multispectral satellite image data it was possible to create fused image data with very good resolution and true colour quality. To create the 3D images and virtual flights we also integrated digital terrain models. The use of satellite data proved a cost-effective solution and also permitted us to produce a realistic representation of larger areas. The standard Landsat TM scenes which cover an area of 185 x 185 km are particularly suitable. To generate detailed 2D or 3D representations it is possible to use very high resolution panchromatic or multispectral satellite data or aerial photographs. The only limiting factor currently is the cost of both the data and the processing that is required.

3.2 Implementation

Our aim was to create animated multimedia 3D information systems. By integrating satellite images, digital terrain models and GPS data we were able to generate highly realistic representations of landscapes and scenery which provide a completely new experience for the users. Animated 3D maps and virtual flights through a 3-dimensional landscape not only allow the users to survey the lay of the land and characteristics from the air, they also allow them to explore villages and towns, look at hotels and find out about major sights and sports facilities. The user slowly approaches the desired destination. Initial glimpses from a satellite give way to a bird's-eye view as the user appears to fly over the region in an aeroplane, hovers above an area to look at it in more detail, and finally touches down in a village or outside

a hotel. By using data fusion it was possible to merge satellite images, aerial photographs and images collected on earth to generate a multimedia information system that offers both general overviews and detailed information.

For several of our previous projects we also used videos and panoramic views to present town squares, streets and buildings (see Figure 3). Inbuilt interactivity features allow the users to obtain an all-round view of the area. This novel type of presenting information is of particular interest to hotels, campsites, museums, shops and leisure and sports centres. A click on the screen admits the user into the lounge of the hotel or reception areas, another click allows him or her to look around, read or listen to the hotel manager's words of welcome, check out the rooms, the restaurant and bar, and the sports facilities. This multimedia-based mode of presentation gives potential customers a much more realistic idea of what to expect, providing far more details than conventional printed brochures can do; the interactivity feature also makes information retrieval more exciting.

Figure 3 : 360 degree panoramic view of Graz

When the users have made their choices, the online-booking feature allows them to directly contact tourist offices and hotels to submit their wishes, ask for tailor-made programmes and price quotations, or simply book their holidays online (see Internet presentation Figure 6, http://dib.joanneum.ac.at/bike).

3.3 Description of technologies

In developing the information system we mainly relied on industry standard technologies and commercially available tools. An important criteria in our selection of suitable systems was flexibility. This is an important factor if we are to ensure that it will be possible to integrate new developments and technologies. For the internet applications we essentially used world-wide-web standard technologies including http, html, xml, Java and JavaScript. For database integration we were able to choose from a whole range of advanced technologies such as ASP, ADO and JDBC.

For 3D visualisations we used VRML and WEB3D; for panoramic views and the presentation of virtual objects we relied on QuickTime VR, IPIX and some JavaVR applications. We have also integrated wireless communication technologies including WAP and WML. There are already a large number of programs available to play videos which can be subsumed under the heading of 'streaming media'. To ensure maximum ease of access we used standard technologies such as MPEG, QuickTime, RealVideo, ASF and AVI.

3.4 Presentation on multimedia CD Rom

For the CD ROM based mountain bike guide we first compiled information on 33 recommended routes around Lake Garda and in the Pasubio area and prepared the data for multimedia presentation. The CD ROM includes satellite images (see Figure 5) of each route and comprehensive details including information about signposts, roadbooks (see Table 1), and over 170 photographs.

The course of each route was traced in a 3D still image to give users a realistic idea of the difficulties of the chosen trail. From this 3D still image there are direct links to cartographic and other tour-related information which significantly facilitates orientation. In addition, 3D flight (MPEG) were rendered for all the recommended routes and integrated into the CD ROM. We also produced elevation profiles for each route from the digital elevation model. These are linked to detailed information about road surfaces, ground conditions etc.
An important factor that needs to be considered whenever new information systems are developed for the tourism industry is that it is impossible to reliably predict which information customers will access and retrieve. Therefore, it is essential that information is presented in a lively and entertaining manner (edutainment). It must be ensured that customers will be have available customized information, ie. information that is maximally geared to their individual needs and takes into account time constraints and specific wishes with regard to content and region. By providing customized suggestions our system tries to respond to customers' personal preferences and select optimal routes for them.

In order to offer a mountain bikers a maximally omplete product range, it was decided that in addition to the CD ROM we also needed a special navigation system, which was developed by Ciclo Sport. The roadbooks shown in Table 1 are

identical with the data contained in the NAVIC chip in the Ciclo Navigation Computer (see Figure 4). The advantage of this computer is that each route point is signalled both visually and acoustically, and that the same symbols and texts are used for the navigation system and for the roadbooks. The CD ROM allows the users to choose and plan their route and to gain a very realistic idea of the difficulties ahead, while the navigation computer then accompanies and guides them to their chosen destination.

Figure 4: Bike Ciclo NaviC

Nr.	KM	HM	SYM.	Ort	Richtung	Weg
0	0,00	66		Start Riva vor Eingang Bar „Central Park“	gerade, Kreisverkehr	Asphalt eben
1	0,14	67		Kreuzung mit Kreisverkehr	rechts, Viale Carducci	Asphalt eben
2	0,91	59		Abzweig vor Hotel du Lac	links, Arco, Straße folgen	Asphalt eben

Table1: Extract from a roadbook used for the BIKE CD Rom

To improve the user-friendliness of the system, we made sure that all data were linked. We used the same symbols for directions in the 3D map, in the elevation profile, and also where appropriate in the photographs / drawings and the Ciclo Navic navigation computer.

3.5 Presentation on the internet

The flexible design of the database permits both the use of the data for an internet-based system (see Figure 6) and their display on computer terminals and CD ROMs. If the information service is to be made available via the internet there are a number of important factors that will determine the success or failure of the project, including quantity of data included, access times and type of interactivity.

New streaming technologies allow the systems developer to display large amounts of 3D data without significantly increasing transfer times. 3D data files are broken down and compressed into smaller pieces, with each individual content piece then being transferred from the website to the user's PC. Landscapes, for instance, start being displayed as soon as the first bytes of the 3D data reach the user's PC. This permits us to send even high-resolution data (textural and 3D models) via the internet.

Streaming technologies are also used for the videos (3D flights) and animations. Unfortunately, however, the quality of these videos and animations is still much poorer than that achieved with PAL or NTSC television screens.
New technologies such as

- QTVR Quicktime VR
- MTS Metastream
- Macromedia Shockwave und Flash
- RealAudio und RealVideo
- Sun Java und JavaScript
- Adobe PDF

permit the direct (and sometimes automatic) integration via internet of the kind of the kind of files that are used for CD ROMs and computer terminals, and so make them available for online users. Figure 6 shows a 3D VRML model with optimised user interface.

Figure 5: 3D map with tour vector (from the BIKE CD ROM for Trentino)

Figure6: 3D Models on the internet (VRML) http://dib.joanneum.ac.at/bike

CONCLUSIONS

All the tourist regions, especially in the Alps, are competing for custom. They are exploring the potential of new presentation strategies that will maximise the promotional appeal of their region and its main assets, which include a unique landscape and scenery, an impressive cultural heritage, and a wide range of sports facilities and other tourist amenities. To ensure the success of target group marketing in the tourism industry it is important that internet-based technologies are used in combination with analogue and digital brochures.

In the future, promotional strategies will increasingly draw on high resolution satellite data and aerial photographs to produce more interesting advertising material. Fundamental to the success of the tourist regions in the future will be the effective use of multimedia data, such as 3D maps, 3D models, panoramic views and virtual flights, which integrate temporal, spatial and thematic information on events, opening hours, reservations, hotel management software, etc., and their availability both on offline media, including computer terminals and CD ROMs, and online media (internet, WAP mobile phones).

REFERENCES

Almer A., Raggam J. and. Strobl D, (1991): High-Precision Geocoding of Spaceborne Remote Sensing Data of High-Relief Terrain. Proceedings ACSM/ASPRS/Auto Carto Annual Convention, Vol. 4, pp. 183 - 192, Baltimore, Maryland, March 25-29, 1991.

Booz, Allen & Hamilton (1998): Durchbruch Multimedia Deutschland im Internationalen Vergleich, BMBF, August 1998

Delius Klasing Verlag (1999): Marktstudie Zeitschrift Bike

Market Research (1999): Marktforschungsstudie AWA ´99 Allenbacher Werbeträger Analyse

Nischelwitzer A.K., Almer A., (2000): Interaktives 3D Informationssystem für Planung und Tourismus, CORP 2000, Vienna, Austria, February 2000

Raggam J., Strobl D., Buchroithner M. F. and Almer A.,(1991): RSG - Workstation Software for Geometric Multisensor Data Processing. In Proc. *Digital Photogrammetric Systems*, Wichmann Verlag, ed. H. Ebner, D. Fritsch, C. Heipke, pp. 313 - 325, Munich, Germany, September 3-6 1991.

Sloggett D. (1997): Earth Observation Data Utilisation, CEO Travel Study – Final Report Project Reference: RGC9B/96

References from Websites

JOANNEUM RESEARCH – member of European Association of Research and Technology Organisations
http://www.joanneum.ac.at

Institut of Digital Image Processing – documentation of reference projects
http://dib.joanneum.ac.at

Bike CD ROM – product description of the Institut of Digital Image Processing
http://dib.joanneum.ac.at/bike