

# **VISPA – A Mobile Digital TourGuide for Mountaineers**

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## **1 INTRODUCTION**

Mountain walking/climbing as one of the major sporting categories today puts high requirements on maps, positioning and guidance combined with many safety-of-life issues (weather, accidents etc.). An intelligent sports assistant can be the key point to enhance the personal sporting confidence and safety of the professional and especially non-professional mountaineers.

The Virtual Sports Assistant (VISPA) presented in this paper is a mobile digital TourGuide for mountaineers with main emphasis on information, guidance and orientation function. It consists of a service provider component and a mobile user component on Pocket PC basis, connected with a GPRS cellular phone, GPS receiver and digital compass. The core services offered to the user include navigation- and general information functionality. The data communication between server and client will be provided via the Internet using GPRS.

In the following a system overview on VISPA will be given.

## **2 PROJECT OVERVIEW**

The VISPA project is carried out in the frame of the ASTRON-Programme of the European Commission and is funded by the EC Joint Research Centre (JRC).

The consortium for the VISPA development consists of the IfEN GmbH (coordinator) and the AGIS Institute of the University FAF Munich. For the development of the user requirements as well as for the later testing period support is given by the German Alpine Club (DAV).

The schedule of the project is as follows:

Start of the project was on 31. January 2001. The duration of the project will be 8 months.

There are four main phases:

- System Definition:  
Definition of user requirements, scenario definition, system design
- PINA Server Development:  
Development of server software, GIS database adaptation, development of tour routing algorithms, generation of localized and personalized data
- TourGuide Development:  
Development of the User Interface, software integration, hardware integration of the mobile components
- Concept Demonstration:

Beta demonstration of the TourGuide (in-house), refinement phase, final demonstration at Spitzingsee (Bavarian Alps)

### 3 SYSTEM AND SERVICE DESCRIPTION

#### 3.1 System Overview and General Service Description

Especially in mountainous regions with a thin path-network, the user needs assistance by answering the following questions:

- Where am I?
- What is my location in a frame of reference that I can understand?
- Where is my destination?
- How can I get there?
- Does the proposed way hit my requirements regarding length, height differences etc.?

The Virtual Sports Assistant (VISPA) consists of the ‘Service Provider’ component Personal Information and Navigation Assistant (PINA)-Server and the Mobile User component ‘TourGuide-Device’. Both together enable complete tour guidance for mountain walkers. The user sends requests for routing, tourist information etc. to the PINA Server; the server generates the relevant data according to the user request and sends them to the ‘Tour Guide’. The following figure outlines the overall VISPA system architecture.

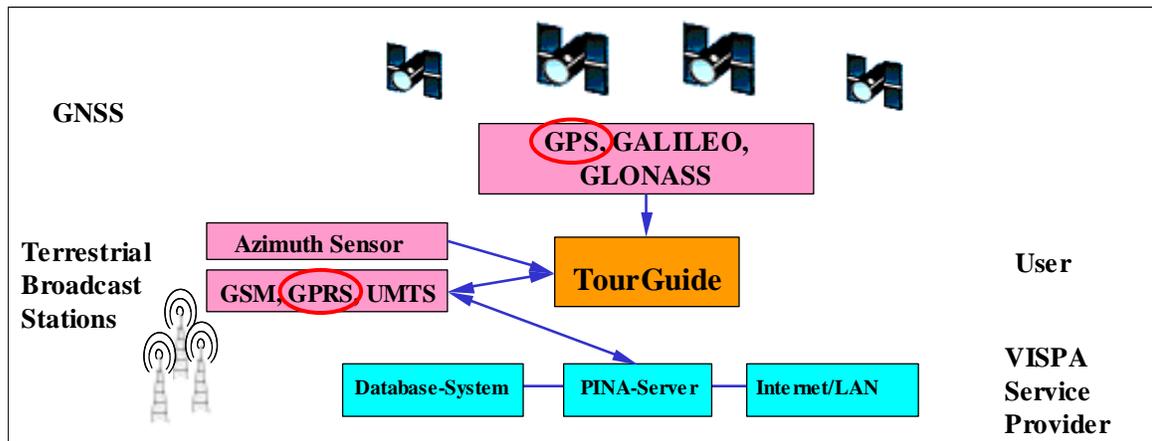


Figure 1: VISPA System Architecture

The user is equipped with the Mobile Device that consists of a mobile info-terminal, a satellite navigation receiver and a digital magnetic compass. The position is determined via GPS and an accurate orientation is given with an electronic compass. A positional accuracy in the range of 5-20 m is accessible since the US-DoD switched off the artificial dilution of precision (selective availability SA) in May of the year 2000.

The Mobile Device communicates via broadband-communication with the PINA-Server. Based on the positional information and additional user requests, the PINA-server provides the user with the following services.

## 3.2 Core Services

### Navigation Service:

The PINA server provides Geo-Information (2D-maps, 3D rendered images) on request according to the user's current position. Three kinds of on-line tour routing services are offered by the PINA server:

- Start destination routing: the user selects start and destination point; the PINA server provides the appropriate route
- Routing to the nearest refuge: the PINA server provides the route to the nearest hut
- Lost-trail routing: the PINA server provides the route back to the nearest trail in case the user lost his trail

Based on the received data the mobile device is capable of providing tour guidance information to the user.

### General Information Service:

Additional personalized thematic data (Tourist data) is provided from the PINA-Server on request. This data contains e.g. the names and business hours of huts, the names and height data of mountain summits etc.

The position of relevant points can be displayed in a map. A routing to these points can be performed and presented as described under "Navigation Service".

### Extended Functionality Options:

In addition to the service functions given above the implementation of extended functionality is possible (but not done within this project):

- Perform routing with constraints (duration of tour, severity of route etc.)
- Emergency call (including exact position of caller)
- Personalized tracking / Group tracking
- Weather forecast (forecast especially for the user's location)
- Update functionality (user can add new information to the central database)

Depending on his requests the user will get the following types of information on his screen:

- 3D rendered terrain visualization of the surroundings
- Proposed path as line signature as visible in the terrain from his point of view
- Distance to the destination and to the next waypoint
- Direction to the destination and to the next waypoint
- Derivation of the orientation of the Mobile Device to the line of sight, presented with arrows (see Figure 6)
- Presentation of the proposed path with its waypoints in a map

### 3.3 Model-Description

As already outlined in chapter 3.1 the concept of VISPA is based on the interaction between the mobile device and the PINA server:

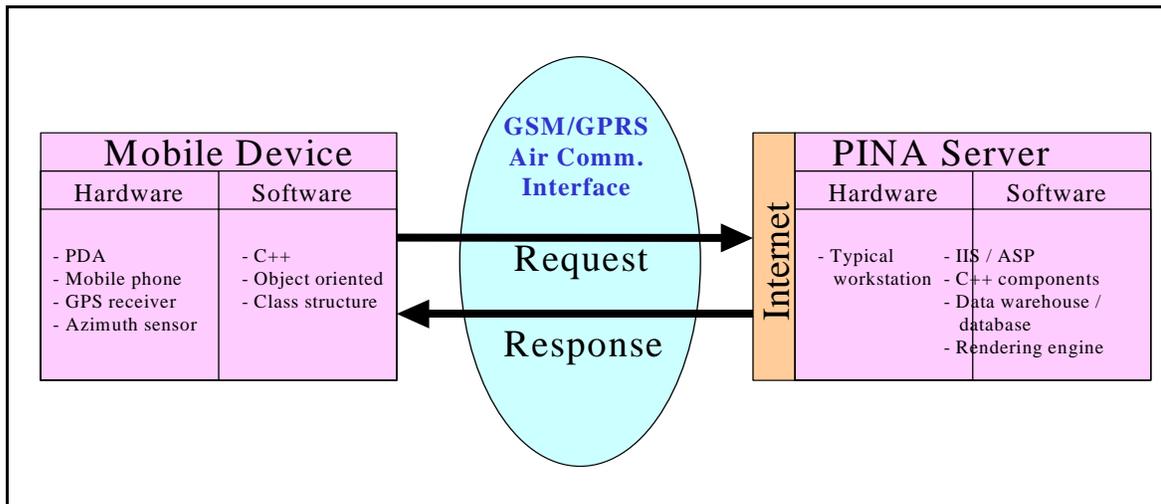


Figure 2: Logical/functional model of VISPA

Using a cellular phone the mountaineer can connect to the Internet, which makes it possible to use standard Internet request via HTTP and standard data provision in XML format.

UMTS is not yet available, so the General Packet Radio Service (GPRS) is used instead for the communication between mobile device and PINA server. As the user has to pay for the amount of transmitted data (independent of the time he was connected), he can stay “always online”.

Figure 3 schematically shows the complete chain of communication between mobile device and server.

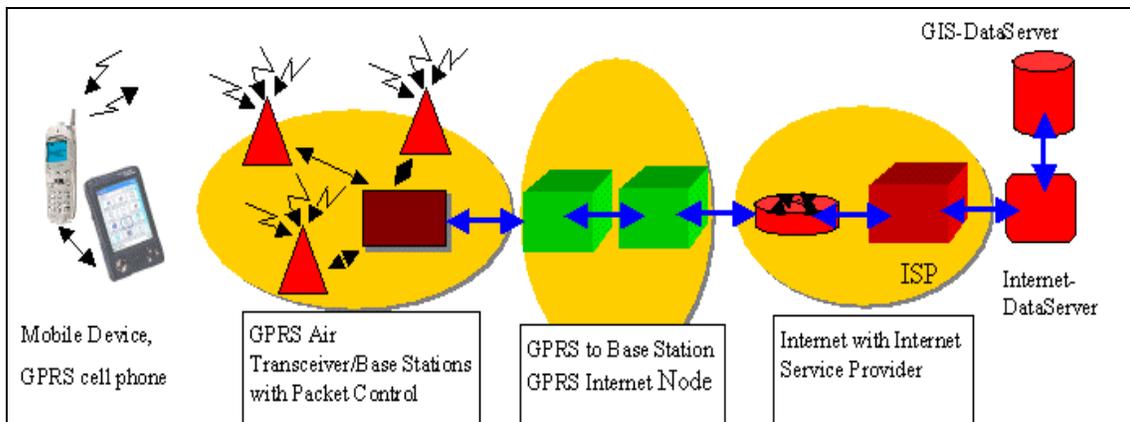


Figure 3: Client/Server Communication

### 3.4 Exemplary Scenarios

In the following some typical underlying scenarios in the usage of the VISPA are exemplarily described in brief:

#### **Start-Destination Routing:**

The user is on his starting point and has no definite idea of his destination

- The user requests/receives hotspots (points of interest) from the PINA server.
- For some of the hotspots, he is especially interested in, he requests/receives further information (e.g. name/height of a summit, name/business-hours of a hut).
- Based on this information the user makes his decision about his final destination and requests the routing to the specified point.
- The routing is performed on the PINA server and the result is transferred to the client.
- The trail to the user's destination is displayed on the mobile device together with some additional information (direction, distance).
- The user is walking along the trail and can view his current position displayed in the map.

#### **Lost-Trail Routing:**

The user has lost his trail or just wants to know how to get to the nearest trail

- The user sends a lost-trail-routing request to the PINA server.
- The routing data is calculated on the PINA server and transferred to the client.
- The route is displayed on the mobile device (as above).

#### **3D-rendered Image:**

The user wants to get a 3D-rendered image with route overlay to compare it with the real situation for a better orientation

- The user requests/receives a 3D rendered image according to his current position from the PINA server.
- The derivation of the user's line of sight is displayed.
- The user turns to the displayed direction, until the derivation of the orientation is zero (→ image matches the real terrain sight).

The following figure gives a schematic overview of the client-server interaction for the routing scenario.

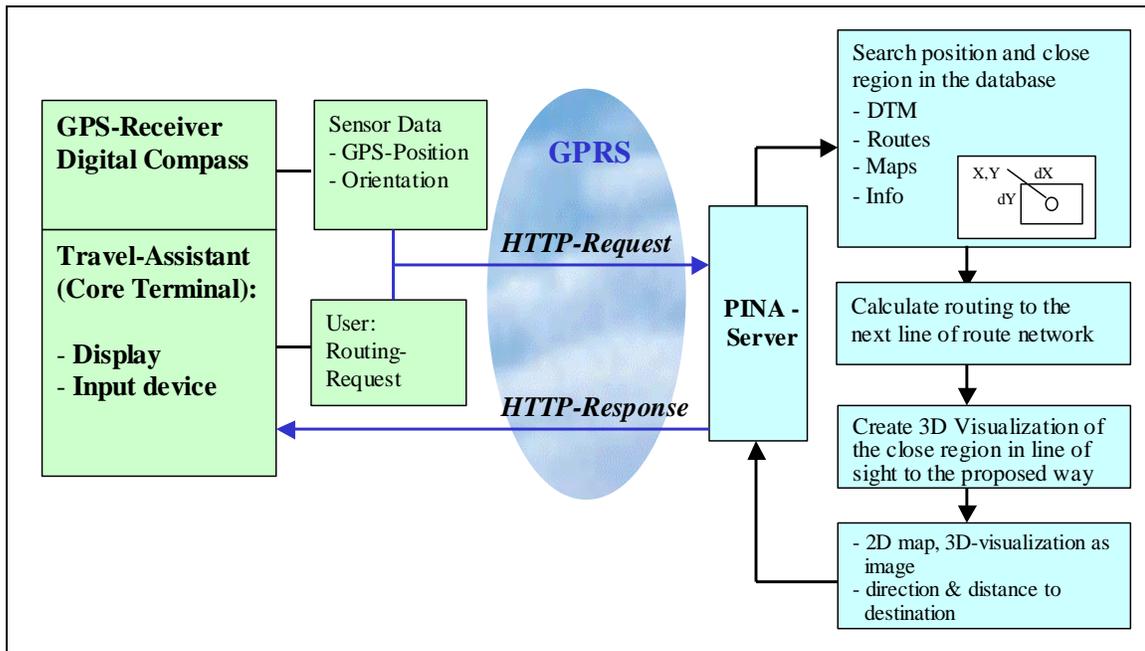


Figure 4: Exemplary Routing Scenario

## 4 MOBILE CLIENT ARCHITECTURE AND SOFTWARE

### 4.1 General Options

In principle one can think of several kinds of devices for the core terminal and the navigation-/communication units (see Figure 5). There is a wide range of portable computers from notebooks up to organizers. As it is the aim of the VISPA project to provide the mountaineer with a compact and easy-to-handle mobile device a PDA was selected. For communication a GPRS cellular phone is necessary. There are only very few relevant models available at the moment.

The final intention is to have a multi-mobile device, which combines the functionality of the PDA and the mobile phone. However, such so-called smart phones are not yet available off the shelf, respectively not appropriate to be used for the VISPA project.

GPS receivers are available as separate handheld devices (to connect via serial cable) as well as plug-in modules for the PC card or CF card slots of the mobile computers.

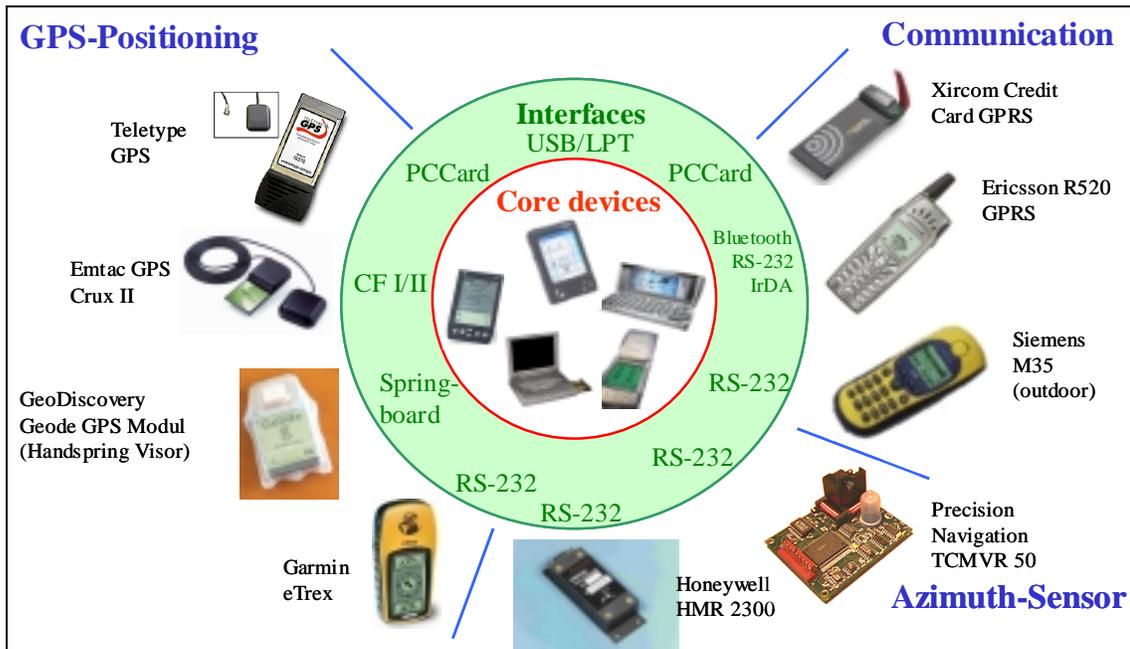


Figure 5: Integration Options of TourGuide Components

## 4.2 Final TourGuide Configuration

In Figure 6 the final configuration of the selected TourGuide hardware components and their corresponding communication interfacing is given.



Figure 6: Final TourGuide Configuration

### **4.2.1 Detailed Hardware Description**

#### **Core Terminal: Pocket PC Casio EG-800**

This is a high performance Pocket PC for industrial/outdoor use which offers full color graphics display (240 x 320 pixels) and extended interface capabilities: The IrDA Port is the interface to the communication unit, the Compact Flash card slot for the navigation unit. The digital compass is connected via the serial interface. The operating system is Windows for Pocket PC (Windows CE 3.0). Some relevant specifications:

- CPU: VR 4122 (150 MHz)
- Memory: 32 MB
- Battery life: up to 13 hours
- Weight: ca. 300 g

#### **Communication Device: Motorola Timeport 260**

The Timeport 260 is a tri-band cellular phone capable of combining 3 GPRS downlink channels. The connection to the PDA is done via the IrDA interface. Some relevant specifications:

- Talktime: 120 – 210 minutes
- Standby: 40 – 150 hours
- Weight: ca. 110 g

#### **Heading Device: IfEN/TCM 50 Azimuth Sensor**

This 50° tilt-compensated compass device is assembled (housing) by IfEN GmbH and bases on the sensor TCM50 from Precision Navigation. It provides the heading (NMEA protocol) information with an accuracy of 3 – 5 degrees. The TCM50 is connected to the PDA via the serial RS-232C interface.

#### **Navigation Device: EMTAC Crux II GPS Receiver Card**

This GPS card is a 12 channel GPS receiver that comes in a Compact Flash (CF) form factor suited to directly connect to the Pocket PC. The Crux II GPS receiver card has an in-built EGNOS/WAAS capability that allows for position accuracy improvement.

### **4.2.2 Software**

For the development of the Mobile Client software the MS embedded Visual C++ 3.0 together with the MS Pocket PC 3.0 Software Development Kit are used. This development environment has the same U/I as the standard MS Visual C++ IDE and allows it to emulate a Pocket PC on the desktop PC.

On mobile client side four major software components are developed:

- User interface: performs display and data-viewer tasks, dispatches commands etc.
- Communication interface: manages the requests/responses to/from the server; interface to real external communication device
- Navigation interface: decodes the positioning and heading information from the navigation HW
- Application Logic: requests and manages map data, routes and points of interest

## 5 SERVER ARCHITECTURE AND SOFTWARE

In the following chapter the PINA (Personal Information and Navigation) server within the VISPA project is outlined. The main tasks of the PINA server are storing geoinformation, processing the request from the digital tour guide and providing the result in a suitable manner to the mobile client.

The server consists of three major components. The first one is a communication interface that is responsible for receiving the request from the mobile device, calling the necessary functions for the geoinformation production and ensuring that the mobile client receives the results. The second component is the geoinformation production component. Depending on the kind of request the appropriate geoinformation in most cases related to the current location of the user are generated. To allow for this geoinformation production different kinds of data must be available. Therefore the third component of the PINA server is a data warehouse that manages all necessary data.

Figure 7 shows an overview of the PINA server. In the following chapters those components will be described in more detail.

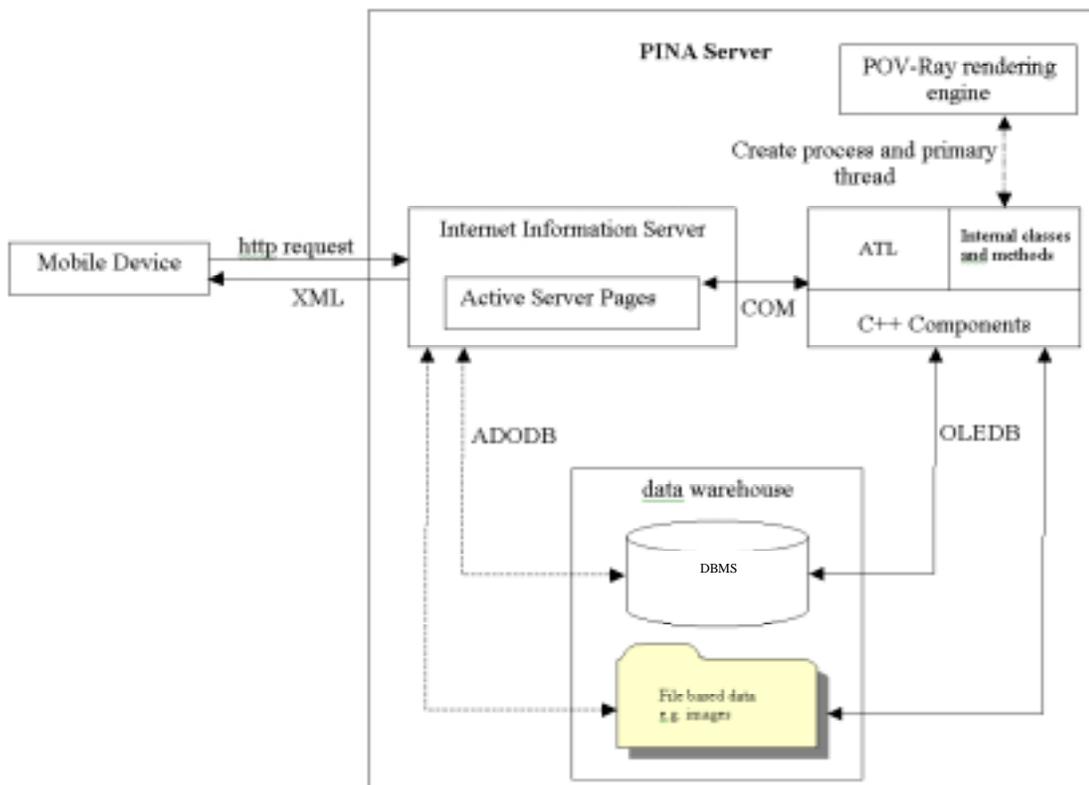


Figure 7: PINA server architecture

## 5.1 Communication Interface

To realize the communication between the mobile device and the PINA Server the http protocol, e.g. known from the World Wide Web, is used. The mobile device sends its request to the Web Server respectively the PINA server. Depending on the kind of request (perform routing, show a map, ...) different ASPs with various parameters (location of user, desired destination) are called from the mobile device. The results of the request (heading, a map, set of waypoints, ...) as well as the requests from the mobile client itself are transmitted using XML. The great advantage of using XML in both directions is providing a standard mechanism, which is an extendible and easy to access interface as XML parsers are available for nearly every programming language. The whole communication on server side between the mobile device and the PINA server is handled by the Microsoft Internet Information Server (IIS).

## 5.2 Components for Geoinformation Production

As not all necessary functionalities can be implemented using ASPs the Component Object Model (COM) is used to get access to C++ routines. Furthermore the use of C++ components ensures a better performance than ASPs as they use interpreted languages. Within VISPA most tasks that accrue during the production of the geoinformation are processed in C++.

The mobile client can request maps, points of interest, factual information and images rendered from 3D data from the PINA server. The rendering engine is the key component to the perspective views generated from the DTM. Within VISPA 'POV-Ray' has been chosen as rendering engine (see Figure 8b).

Another important service provided by the PINA server is the routing functionality. As routing algorithm a conventional start-destination routing based on the routing data in the DBMS will be used.

## 5.3 Data Warehouse

Another major component of the PINA server is the data warehouse. It hosts all necessary data to allow for providing the services described in chapter 3.1. Depending on the type of data they are stored in different ways. Raster data, e.g. scanned maps are stored as images in a file structure. Vector data, e.g. the routing data are handled by a DBMS.

In the following the different kinds of data and their usage in this project are described.

- DTM data  
The data basis for the DTM data is a 1'' (~30.9m) grid covering the whole test area. To achieve a better visual appearance a 10m grid has been interpolated from the original data.  
The DTM data used are used in two cases of the geoinformation production:
  - 3D rendered image  
The DTM data are the foundation to create 3D rendered images (perspective views). They are used to generate a so called 'height field' within the

rendering engine, which allows for texture mapping of images (e.g. maps) or/and a calculated routes onto its surface.

- Determine visibility of poi  
The intent is to use the DTM data also to determine the points of interest visible from the current point of view. This is only necessary in the case the user request a perspective view (3D rendered image) from the PINA server.

- Scanned maps

This kind of data are tiled conventional topographic maps in different scales. The tiling contributes towards minimizing the amount of data transferred between the PINA server and the client as only the necessary tiles are send to the client.

The scanned maps are used in two major categories of geoinformation production in this project. On the one hand they provide maps in different levels of detail to the client. On the other hand they are texture mapped onto the DTM to allow for an easier to interpret 3D rendered image.

- Routing data

The routing data are a mesh of hiking trails and points of interest like huts or mountaintops. Furthermore each edge or node of the trail network has additional information like severity or object class. This allows for using the data not only as a basis for the routing, they also can be used to provide points of interest.

## 6 CONCLUSIONS

### 6.1 First Results and Experiences

The following two figures show some very early examples for the information provided to the user in order to support his navigation and orientation tasks. Figure 8a shows a sample for a two-dimensional, traditional map (user position and path not yet indicated at this stage). Figure 8b shows an example for an image rendered from DTM data. A map and a proposed route are texture mapped onto the DTM.

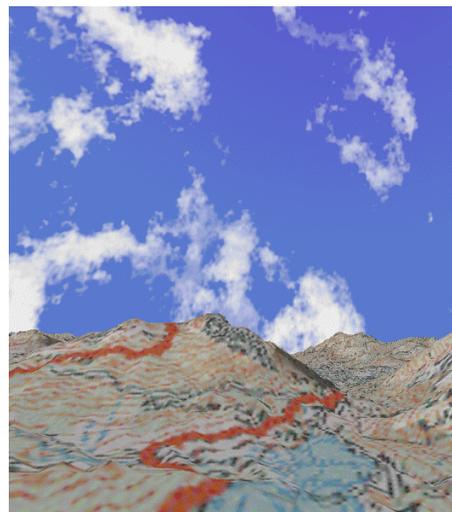


Figure 8 a,b: 2D-Map; Image rendered from DTM data

With respect to practical experiences gained through the work with the connection and configuration of the necessary VISPA hardware, the following two main issues have been identified:

- The communication between PDA and hardware components (GPS Receiver, electronic compass, mobile phone) turned out to be quite difficult due to interfacing issues (hardware and software level). Meanwhile these problems have been widely solved.
- At present, the transfer-rates on GPRS data link are low and do not yet correspond to the announced rates. However, an increase of the data rates may be expected as soon as GPRS will finally be well established.

## 6.2 Conclusions and Perspectives

The presented VISPA concept gives the mountaineer a deep confidence in the activities he is actually performing. This ensures high acceptance of the service (also if it has to be paid for in a later fully operable version), but also should create additional tourist attraction for this sport having such an innovative system at hand.

Furthermore the core services are the essential part for safety-of-life issues to prevent the outdoor activists from critical situations. Loosing the trail can often cause dangerous situations for the mountaineer. Having the possibility to be guided back to a safe trail means a strong enhancement of the user's safety.

There are of course several possible options for extended service functionality as mentioned in 3.2. Some of these functions will be implemented by the project "PARAMOUNT", anticipated to be funded by the European Commission within the IST-Programme under Cross Programme Action 3.

Besides a more compact configuration of the TourGuide hardware will be possible, when the first suitable smart-phones will be available. E.g. the Siemens SX 45 Multimobile is announced to be available in August 2001. This Pocket PC contains an integrated GPRS phone, which means a strong enhancement of the mobile device handling. This will be at least one step to the aim of the "ideal user system", i.e. having just *one single device*.

Another enhancement for the handling will be the GPS device with built-in antenna, available about in July 2001.

## 7 ACKNOWLEDGEMENTS

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## 8 REFERENCES

### Some recent publications of IfEN GmbH on GNSS and GSM/UMTS:

- Balbach, O., "UMTS – Competing Navigation System and Supplemental Communication System to GNSS", *Proceedings of the ION 2000, Salt Lake City, UT*, Institute of Navigation, September 2000
- Hein, G. W., Eissfeller, B., Oehler, V. and Winkel, J. O., "Synergies Between Satellite Navigation and Location Services of Terrestrial Mobile Communication", *Proceedings of the 13. International Technical Meeting, Salt Lake City, UT*, Institute of Navigation, September 2000
- Winkel, J. O. and Eissfeller, B., "Modelling and Simulating GNSS Signals and Receiver in Arbitrary Environments", *GNSS 1999, Genoa, Italy*, Italian Institute of Navigation, October 1999

### Some recent publications of AGIS:

- Caspary, W., Mösbauer, M., "AIDA-Multimedia Alpine Guide Italia. Deutschland. Austria", *Hochgebirgskartographie, Silvretta '98, Wiener Schriften zur Kartographie*, Vol. 11, PP. 169-173, 1998
- Caspary, W., Joos, G. and Mösbauer, M., "Multimedia und mobile GIS", *Zeitschrift für Vermessungswesen*, Vol. 125, PP. 272-279, 2000
- Koppers, L., "3D-Map - Virtual Reality and Geo-Data", *EOGEO 98, Tagungsband Universität Salzburg*, 1998. or online-paper:  
<http://agis.bauw.unibw-muenchen.de/publix/koppers/eogeo/index.html>
- Koppers, L., Schäfer, S., "Touren - Routing mit GIS - Ein neuer Ansatz des Seilanpassungsverfahrens", *GIS GEO-Informationssysteme*, PP. 19-23, 1999
- Leukert, K., Reinhardt, W., Seeberger, S., "GIS-Internet Architekturen", *Zeitschrift für Vermessungswesen*, Vol.125, No.1, PP. 23-28, 2000
- Reinhardt, W., "Geoinformationssysteme - Chancen in der Informationsgesellschaft", *DVW Mitteilungsblatt*, Vol. 51, No. 3 - 1999, PP. 249-264, 1999