Virtual signposts for location-based story-telling

Dirk Ahlers[1], Susanne Boll[2], Daniel Wichmann[1]

[1] OFFIS – Institute for Information Technology

Oldenburg, Germany

{ahlers|wichmann}@offis.de

[2] University of Oldenburg. Germany

susanne.boll@uni-oldenburg.de

Abstract. This paper outlines the development and background for a non-intrusive location-based mobile hiking story guide for the Montafon region in Austria. The system comprises different classes of mobile applications and a remote media server, and is designed to be used by a wide userbase of hikers. Our system allows a tourism agency to put up location-based narratives for points of interest that will be "visible" to users on their mobile devices—both mobile phones and PDAs—on their hiking tour. Equipped with a positioning receiver, users can access location-based information and listen to geo-referenced narrated audio content about their whereabouts as well as retrieve in-depth multimedia content.

1 INTRODUCTION

Mobility is becoming an essential factor, both in our private life and in our pursuit of business. Especially travel and tourism are domains in which individuals and groups are mobile and visit new and unknown cities, regions, and places that they like to discover and learn more about. As mobile devices and applications are becoming a day-to-day companion for more and more people during their daily lives, this trend even continues in people's vacations. Supporting this development, we aim to enhance hiking vacations in the mountains by using mobile devices to support and enhance the user's tours. However, most applications in the tourism domain are very specialized and complex systems and are not quite fit for casual usage. Judging from available devices alone, there is not a one-device-fits-all approach thinkable. Also, hikers are too diverse a user group. Two ends of the spectrum are formed by casual users who want an easy-to-use device with easy and known interaction and by technically-savvy users who want the most information on the latest devices. Thus, the goal is to bridge the gap between these user groups and to offer adequate systems for both by allowing ease-of-use and full functionality and multimedia support.

Figure 1. Real and virtual signposts

Therefore we propose an overall system which is based on two complementary mobile device classes. Similar to previously developed tourist guides [Scherp and Boll 2004] and based on our research background in mobile applications [Baldzer et al. 2004] and context-aware and multimodal interfaces [Krösche and Boll 2005], [Henze et al. 2007], we developed an integrated mobile hiking assistant system. We aim to introduce a virtual sign-posting personalized to the individual user, because today a tourist can only retrieve nonpersonalized information snippets from signposts installed at points of interest or along a route. With our system, a tourism agency can set up location-based narratives for points of interest that will be "visible" to users on their mobile devices on their hiking tour. Equipped with a GPS receiver, users can access location-based information and listen to geo-referenced narrated audio content about their whereabouts.

Generally, the applications and scenarios are designed to be directly implemented on site for direct use by tourists and thus rely on standard affordable hardware components. The availability of an easy-to-use location-based tourist guide can be used to increase the awareness of tourists' vacation area by using known and familiar devices and metaphors. Initial feedback from the evaluations is very promising and encouraging for the continuing development of the system.

2 TOURISM RELEVANCE

Today, conventional tourism uses techniques such as signposts or brochures to convey information during a hike or for preparation. Additional or in-depth information usually cannot be accessed during a hike. However, additional rich multimedia information allows hikers to learn more about their surroundings and appreciate their vacation area and allows deeper insights about its relevance. Personalization of this information allows for a better and more well-received presentation of information with the content

adapted accordingly. This covers users that are interested in cultural history and others that might want detailed information about nature. Such a wide field of interests cannot be addressed by traditional signposting. Additionally, an effective transfer of information only by text or a few images prepared for a broad user group cannot easily convey advanced in-depth information. Using personalized multimedia presentations with combinations of audio, text, and images increases this transfer significantly, because the hiker primarily receives the information of interest in an attractive tailored presentation. Another relevant criterion for the tourism is the maintainability of digital content. In contrast to the traditional infrastructure with signposts or brochures, it is possible to change digital content at a single point of access or from a remote location, e.g., a content server or content management system. This also includes a simpler way to incorporate new content. An issue of great relevance for touristic regions is also the regional image in terms of visibility. New media-technology-driven approaches can improve the image of a region and are able to address and attract new groups of potential users such as young and technically interested people. Recently, in the pilot region for our project, the Montafon in Austria, a phone service has been implemented which posts telephone numbers in prominent locations. These numbers can be called to retrieve in-depth narrated audio information about the specific location from a phone server (t-guide.telesis.at). However, sign-posting can be the solution for only a limited number of locations as the effort is high to maintain or extend them on a large scale. In addition, they refer to information that is the same for all visitors and no personalization towards special interest or target groups is possible.

Several projects address these issues by means of interactive tourist guide applications based on mobile devices. Relevant research projects in this area are for instance the GUIDE project [Cheverst et al. 2000] of the University of Lancaster which presents personalized multimedia tourist information for visitors of the city of Lancaster. The same application domain is addressed in LoL@ [Umlauft et al. 2003] in Vienna, which utilizes UMTS to locate the user and to present multimedia data about interesting spots on a mobile device. LiMoG [Retschitzegger et al. 2006] is another tourist guide focusing on a light-weight approach implemented as a prototype for the city of Linz. These projects underline the relevance of such systems for the domain of tourism. Typically, these types of applications not only provide multimedia information, a digital map and user’s location, but also integrate geo-referenced points of interest (POIs) which associate the multimedia background information with a concrete location.

Commercial vendors of navigation software or hardware often focus on the car navigation task, but are beginning to cater to pedestrian users as well with adapted navigation. However, information and entertainment often fall short. Conversely, applications such as Nokia Maps or TomTom also offer information about the surroundings and allow the integration of large POI databases. At the moment, these only work on their dedicated hardware, thus severely limiting its availability to users. Also, no tours or in-depth multimedia presentations are available.

These systems follow a one-for-all concept or require powerful devices which are not yet commonplace. In contrast to the other approaches, our overall system appeals to a larger number of users who can use the application, because we implemented the system as two applications for different device classes. One has a reduced functionality without map presentation and voice output only, whereas the other is enriched with full personalized multimedia support and map presentation. The first one can be used on almost anyone current mobile phone and is thus able to run on the user's own well known device. In contrast the second application requires a modern PDA which is not yet commonplace, but can therefore be rented at the tourist agency. Both applications introduce the metaphor of virtual personalized sign-posting to the individual user. Virtual signposts are represented on a device and refer to location-based multimedia information about points of interest in the real world. We expect this to increase the general acceptance of mobile hiking assistants.

3 SYSTEM DESIGN

The overall tourist guide system is named Loccata[1] according to the project within which it was developed. It is organized into three layers as shown in Figure 2 to allow content creation and management, distribution and use on mobile devices. The content management layer supports the production and management of the content for the overall system. The content is prepared within an adapted content management system (CMS) and is also available on the Web for dissemination. The Web interface is available at galileo.telesis.at for perusal or installation of the produced content. The information in the CMS is divided into media items which are currently text, images and audio together with additional metadata such as type of information or category (e.g., nature, sport, culture) or suitability (children, families etc.). The media items can be combined with a location coordinate and further metadata such as title and description to form points of

[1] Loccata Consortium. Information at every turn. http://loccata.telesis.at/.

interest. The POIs then contain multimedia presentations that refer to a location in the real world. A route can be defined which consists of a set of POIs, a recommended hiking track, and route information. Media items as well as POIs are reusable to allow routes to share POIs and for separate POIs to refer to e.g. identical background information.

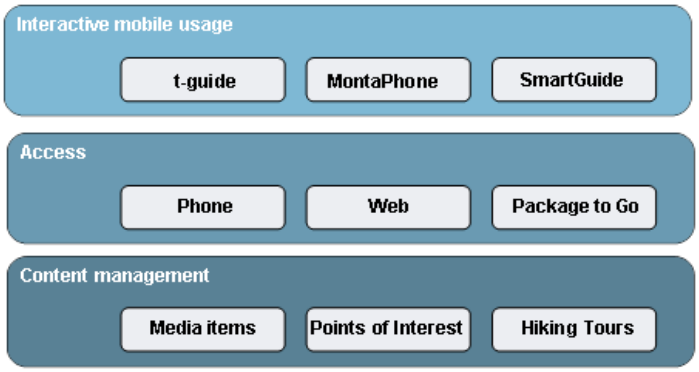

Figure 2. The three layers of the overall Loccata system

The access layer provides methods to distribute, deploy and access the content which is located in the CMS layer. The interface for Web allows it to integrate the content in touristic websites whereas the phone interface enables the access to the audio data by means of phone calls. For the phone interface a phone server replays spoken audio corresponding to certain phone numbers. Another method to deploy the content is the export by means of a package-to-go. This package includes all necessary media items, corresponding meta-data, POIs and descriptions for the specified route tailored to the device class. On the top level—the interactive mobile usage layer—there are the different mobile applications which use the content via the access layer. One application is the preexisting t-guide which is integrated in the overall system design and allows audio access by a phone server. The other applications are the two complementing mobile systems which were developed in the project. One is the MontaPhone which is a small easy-to-use java application that runs on mobile phones. Within the larger frame of development, this application is but an intermediate step towards deploying a full-scale PDA application for those users who demand a full multimedia experience while on the hike. That solution is realized in the SmartGuide which is a fully-functional mobile guide application. In both of our applications, we use different context properties for adaptation to the user. Apart from location as the main context information, we use language, either user-provided or by auto-sensing from the current device, to present the correct selection of the rich multilingual content available to users. Other context information is used to tailor the information to the individual user. The users' location is acquired by global naviga-

tion satellite system (GNSS) positioning receivers. Summarized, the two applications represent two classes of media accessors; one, for light-weight devices, connects to a media server to access media content referenced by location-based playlists; the other contains all relevant media as a full package in advance for a richer media experience on a hike.

4 MontaPhone – Shortcutting the Way to Location-Based Phone Services

The light-weight MontaPhone application [Ahlers et al. 2007] is designed to run on most common mobile phones. Via an off-the-shelf external positioning receiver or a built-in internal one, a user's current position is constantly compared to a list of included points of interest (POIs). At any time, the user can at a glance get an overview of all POIs in his or her vicinity. The approach to a POI is signaled to the user who can then proceed to look up further information about it. Narrated prepared audio information is available on a media server and can be listened to through the application dialing the corresponding number and initiating a phone call. In our scenario, the user can carry the device in the pocket all the time and can be sure to be alerted if he or she gets near a POI, thus generally having the hands and eyes free for hiking and enjoying the surrounding area. For a quick orientation, the application shows a list of all POIs in the surrounding. This light-weight application combines location-based techniques with a familiar device and the familiar task of using a mobile phone.

The application is targeted towards a casual user and allows for a casual interaction on wide spread devices without any need for specialized equipment. The application follows known and acquired means of interaction since it runs on a common device and uses the well-known interfaces of a cell phone. To utilize the wide range of mobile phones already in user's hands today, we place only minimum demands on the device. Thus, while most other commercial applications would run only on mobile phones from a few selected vendors, the MontaPhone can be deployed on a far wider range of phones.

4.1 Architecture

The MontaPhone system comprises a mobile application and a remote media server. Figure 3 shows key aspects of the client-server communication and the overall architecture. The mobile phone, equipped with information from a media server, uses GNSS to determine its position and allows the user to initiate location-based phone calls back to the server.

Figure 3. Architecture and concept of the MontaPhone communication

The content design provides general descriptive information for each point of interest as well as narrative audios prepared by a professional speaker, giving background information about the point of interest. Necessitated by the huge size of all available audios, a separation of metadata and actual content was enforced. The mobile application comes equipped with POI metadata and initial content already on the phone to allow an overview of local POIs and proximity detection. It is bundled as an easily installed jar file (Package-To-Go). Once more information is desired, the POI's associated phone number within the telephone server can be dialed for audio content. The audio is then replayed over the telephone connection. The approach of initially bundling the POIs with the application eases the deployment for both user and service provider. Download and installation of the application can be done by PC-based transfer or wirelessly over-the-air. This approach is viable for information that does not change often, such as the location of POIs. Also, new POIs are only added seldomly. The main contents are stored on a telephone server and could be changed at any time. Also, the large amount of audio files would be difficult to transfer to a basic cell phone today. By storing all metadata on the device itself, it is immune to disruptions of service for both network connectivity and location availability and the basic features stay functional. Of course, for retrieving the audio data, a phone connection is necessary. The approach of using initial location information to retrieve heavyweight media content on demand over voicebased cellular data networks is very well suited to small devices.

To develop a lightweight mobile phone hiking assistant application, we used selected modules of our mobile application development framework (cf. Section 5.3) and adapted it for use on a Java-enabled phone. Complementing existing approaches of accessing broadband networks [Baldzer et al. 2005], the application relies on standard GSM phone services for content access since this is the most stable means of access in the rural moun-

taineous region. Employing the Java Mobile (J2ME) Bluetooth capabilities, mobile phones equipped with the Bluetooth API can be used to query an external positioning receiver for current location. The application accesses internal GPS-receivers, if present. In cases where no GPS device is available, several fallback procedures allow the system to degrade gracefully down to a mode where only POIs are displayed without distance-based ordering.

4.2 Interaction Design

With the inherent ability of a mobile phone, it is rather natural for a user to use it to initiate a voice connection. Using the telephone metaphor inside the application is an interesting way for media distribution, especially for heterogeneous information sources such as small packets of general information and large audio contents.

With three steps as depicted in Figure 4, a user can retrieve the own position and a list of POIs and retrieve additional narrated information. After starting the application, the external GPS receiver has to be connected with the assistance of a wizard or an internal receiver can be used. Then a list of POIs in the vicinity is displayed which can be activated by the user to initiate a phone call to retrieve spoken audio about the specific POI.

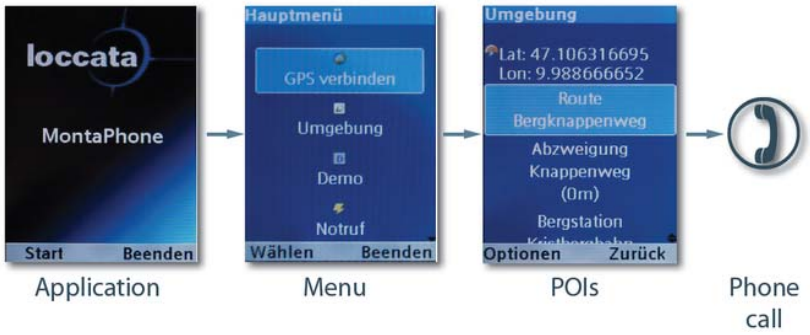

Figure 4. MontaPhone user interaction

Given the restrictions of development for the majority of mobile phones, some cut-backs were made. No map view was used for improved stability and accessibility for more mobile phones. The graphical list used instead, can fall back from the graphical view to a purely textual presentation on older phones. To maintain location-awareness, the user's current position is displayed with the POI list. Direction to individual POIs (e.g. "90m, SW") is textually given for the user to orient. Without an integrated compass, it cannot be reliably graphically displayed. The MontaPhone can also be simply used for orientation without the need to phone in for additional information and will then only display distance-ranked POIs. To ease configura-

tion, the application auto-senses the language of the phone and adapts accordingly. The system forms a tiny unobtrusive companion that employs different modalities to actually meet the users in the actual situation of hiking and allows them to enjoy the tour and relax, but still be informed about their whereabouts any time they want.

5 SMARTGUIDE – ENHANCED HIKING EXPERIENCE

The SmartGuide is loccata's high-end hiking guide. Its hardware of choice is a modern PDA with a sufficiently large display and sufficient computing performance. Because of the larger display, the higher computing power and the storage capacity of these devices compared to regular cell phones the realization of more ambitious applications is possible. Thus the SmartGuide takes a step further than the MontaPhone and is able to provide a multimedia enriched hiking experience with personalized information for tourists. Using a positioning receiver such as GPS (or later Galileo), the guide visualizes the current position on a geo-referenced map and displays in-depth information about the users current surroundings.The devices required for the SmartGuide are not yet commonplace. Therefore tourists can rent the system as an all-in-one package at the tourism agency or other rent stations but also use their own device.

The SmartGuide assists hikers on their tour by means of a PDA-based application. For easier handling for the hikers, the rentable devices are ruggedized PDAs with integrated GPS receivers. Not only do they present a single device solution to tourists, they also are proofed against shock and liquids and are thus extremely suitable for hikes. The system is configured to the language of choice and users can choose the route or routes they want to hike. These routes include general information about the tour itself, the track to walk as well as places of interest along the track in the selected language.

5.1 Architecture

The communication and deployment architecture of the SmartGuide presented in Figure 5 is similar to that of the MontaPhone as it shares the same backend systems (cf. Figure 3). The phone call access, however, is not needed as all relevant content is transferred to the device at deployment time as a comprehensive media package. The PDA has much more storage capacity compared to mobile phones and can carry all data and content for the selected routes without need for a connection to externally stored content. The audio content is the same for both MontaPhone and SmartGuide with the latter also containing additional media items such as text and im-

ages. The media items and metadata are assembled as packages-to-go. One package includes one route, but multiple packages can be installed.

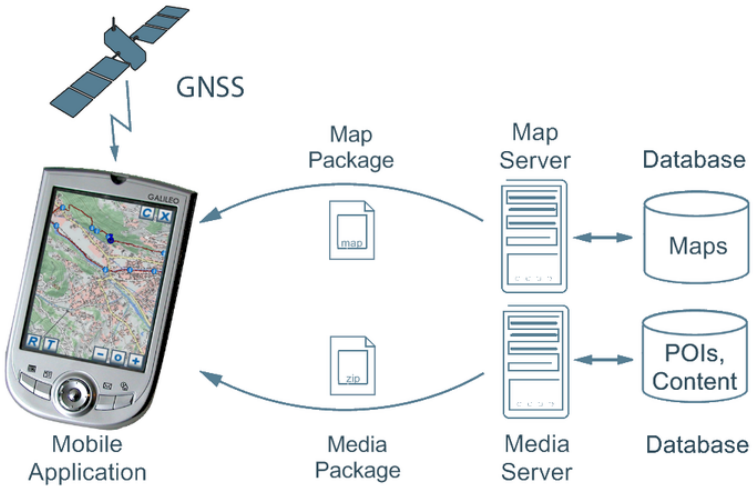

Figure 5. Communication and deployment architecture of the SmartGuide

Another enhancement compared to the MontaPhone is the display of the current position and the surroundings on a digital interactive map. The map is a geo-referenced export from a geographic information system (GIS) that is used in the region for, amongst others, management of hiking paths throughout the region. It is specifically prepared for use within the SmartGuide as a combination of various layers relevant to a hiker and with a color scheme to be easily readable on the device. The map is split into a set of tiles for optimized usage in the application. A region consists of one or more tile sets representing different zoom levels. Similar to the content, the maps can be transferred onto the device as a package-to-go. Each package consists of one region and—if available—includes different zoom levels. The maps and routes can be transferred and substituted independently. This allows providers to, e.g., update single routes or to add new tours on existing maps. The SmartGuide imports the currently available data at start-up and can work independent during the hike. The positioning is based on GNSS via internal or external receivers.

5.2 Interaction design

A SmartGuide walk-through is shown in Figure 6. After renting the system the tourists can choose a route on their mobile devices at the beginning of a hiking tour. They can browse the available tours and see detailed information about them such as difficulty, length or highlights. Thus, the users are able to search appropriate routes according to their preferences and abilities. The map view then primarily displays POIs and the users' current position on the map to help them orientate themselves. Users can shift and

pan the map, zoom in and out as well as snap back to their own position. If a valid position is not available (e.g., due to missing GPS signal), the application presents the map without the user's current position but is otherwise fully functional. An overlay draws the recommend track of the current route and additionally the track they have hiked so far. Depending on the hikers' preferences the map also shows places of interest close or related to the chosen route as icons.

Figure 6. The SmartGuide user interface

When reaching or selecting such a POI the users can get detailed location-based information in different languages, levels of detail or area of interest. The user can input his or her preferences within the application and select which information should be presented in the personalized view. This information presents highlights of the natural and cultural landscape and creates an intense hiking experience. Beside the presentation via text and images the highlights of the landscape are also introduced by narrated audio. This allows for a very effective knowledge transfer and makes the region along with its places of interest and highlights accessible to its visitors.

The operation of the system—usually by moving a pen on the touch-screen—is optimized towards being able to use simply a finger for operating the touch-screen, thus reducing the necessity to always use a pen. The graphical user interface elements have been adapted to this mode of usage. Listening to the narration the hikers have the opportunity to have free hands and sight while they are walking but nevertheless be notified of places of interest or important information. This makes for a much more unobtrusive assistance.

5.3 Platform and Framework

When developing mobile applications we can often observe that basic functionalities are shared by a range of different applications. These are for example location determination and visualization as well as presentation of points of interest and multimedia contents. Based on this observation the Niccimon platform was designed which provides these basic functionalities as independent modules [Baldzer et al. 2004]. Developers can use the modules as building blocks for the construction of their own mobile applications. The platform also provides functions for the visual and auditory presentation.

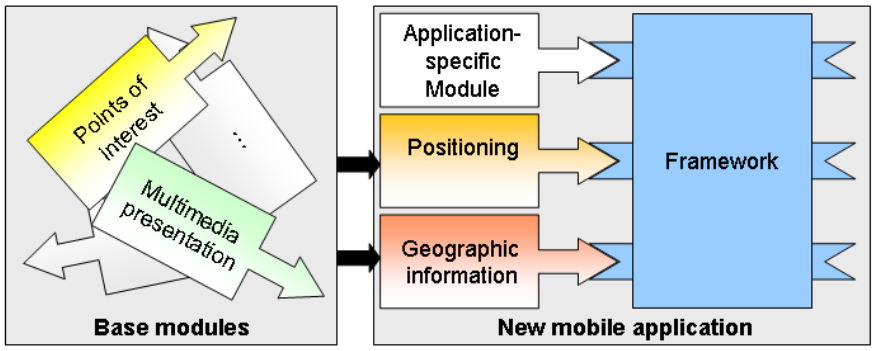

Figure 7. The building block concept of the Niccimon platform

The reusability of existing modules allows developers to realize their application ideas much faster, because they do not have to re-implement often used functions and a significant part of the difficult development for mobile devices is covered by the framework. Figure 7 shows that a new application can be created by simply assembling existing building blocks and by adding new application specific functions via new modules. The Loccata hiking guide application is developed and based on this concept and platform. After an initial framework design phase, the realization of the application is greatly improved. This building block concept allows for flexibility, extensibility and adaptability. If new future requirements arise, they can be easily integrated in the existing system. The currently used modules can be modified or substituted by new ones which meet the new requirements. This mechanism simplifies the integration of Galileo support as soon as the satellite system will be ready and the appropriate receivers will be available.

6 Feedback and Evaluation

The integration of users was a highly important issue in Loccata. Right from the beginning, the project idea was publicly presented to tourist offi-

cers in the Montafon in Austria, and the requirements, ideas and suggestions they gave were carefully considered. During the development, several live tests and preparations of the system were made by undertaking hiking tours with user groups, developers, and project leads. These real-life-tests proved to be very valuable, ensuring that the resulting system is not only technically operational but can also practically be used. Moreover, these tours were used to collect additional track and media data for later use. They also helped to prepare demonstration videos of the system (cf. http://www.youtube.com/watch?v=Kg3-ii1XNCc) and to conduct interviews with users. Regional multipliers such as the majors of the Montafon towns were also invited to raise interest in the project, enhance the systems and their usage within the Montafon region, and to add a commercialization angle to the project.

Demonstrations have been organized for selected Montafon tourist organisations and have received a great interest, a very positive feedback and a clear commitment towards the introduction and usage of the system as a part of the regular tourism offers. The first demonstrations and tests gave important input and suggestions for further development. Issues included interface design, content preparation, and information density and readability on the devices. The handling of the devices worked smoothly. While a hiker equipped with a PDA may be an unusual sight, all test subjects were already very familiar with mobile phones and other mobile devices and had no problems operating the applications. One of the outcomes of the real-life tests was that the selection of the proper hardware is important for the operation of the system. Having tested various PDA systems, we opted for the use of robust, ruggedized PDAs as seen in Figure 8. In general, the devices themselves proved to be well suited for the task, with readability and battery capacity sufficient even for prolonged hikes.

This continuous engagement in practical tests proved invaluable for the final user feedback. The user groups liked both the idea and the implementations within the Loccata system and see a very high potential for the mobile clients. The MontaPhone application received praise for the ability to easily call the phone server with a common mobile phone. However, with the lack of a map view, most participants opted for the SmartGuide as delivering the better overall hiking experience.

Figure 8. The SmartGuide (left) and the MontaPhone during a hike

Currently both applications are deployed in the Montafon region and can be used and rented by interested tourists. The Loccata system is an example of an up-to-date touristic offer which will be disseminated into other touristic regions as well. Recently the system won the second place in the Austrian "ebiz egovernment award 2007" (http://www.report.at/award/) on a regional as well as on a national level and was commended for innovation and practical relevance.

7 OPEN ISSUES

The location-aware applications developed within the project rely on GNSS technology for positioning of the user. Pending availability of improved systems, the current GPS was used. A major issue in this case were inaccurate GPS positioning results. With current GPS receivers the accuracy and availability of positioning is improved compared to older ones. Still, areas where objects disturb the signal like dense forests with close canopies or steep slopes prove difficult even for current hardware due to issues of shadowing, multipathing or signal outages. Location-based guides for pedestrians especially suffer from the unreliable GPS accuracy [Ahlers et al. 2008], a symptom that is increased in this special case. The integrated solution of a ruggedized PDA with internal GPS was a huge advantage in terms of handling, but the quality of the internal positioning was persistently worse than that of external receivers. Since routes within the Montafon will most likely be declared properly by signposts a full navigational aid is not necessary for hiking tours in this special scenario. At this state, we chose to drop a full navigational aid and instead to focus on an orientation aid for users to help wayfinding with a detailed map view and clear recommendation for tracks [Richter and Klippel 2002]. For the presented hiking scenario, such an unobtrusive navigational assistance was the approach of choice.

The cost of mobile phone connectivity is another issue that should not be underestimated. Many tourists naturally are from foreign countries and therefore on a roaming leash from their home providers. This results in exceedingly higher and not transparent costs for voice and network connections, discouraging users from calling with the MontaPhone. Making these costs transparent would be helpful in gaining trust and acceptance.

8 CONCLUSION

We have shown how development of a comprehensive location-based tourism system can be used to increase the awareness of their vacation area for tourists by using known and familiar devices and metaphors. Our system combines the advantages of stationary signboards, brochures, and mobility to deliver a complete mobile hiking experience to users. Using two complementing applications and device classes, different types of users can be approached. The MontaPhone application has low requirements with respect to the device and enables the user to easily explore his or her whereabouts with a common mobile phone. Reaching casual and experienced hikers alike, the MontaPhone application is a new and innovative way to easily retrieve in-depth spoken narratives just on the way. The complementing SmartGuide application addresses hikers who are interested in a full-scaled multimedia enriched application based on a modern PDA. It offers in-depth information about the region and selected routes and can be used on the hike or for preparation of a tour as well. Both systems are currently deployed in the Montafon region and available to tourists wanting to explore their vacation area with location-aware multimedia assistance.

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[2] GJU/GSA project number for the Loccata project: GJU/06/2423/CTR/LOCCATA-CA.

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