Mobiler Stadtführer für das Finden und Nutzen touristischer und kultureller Sehenswürdigkeiten

Mobile city guide for locating and using tourist and cultural attractions

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Zusammenfassung:
In diesem Beitrag wird dargestellt, welche Forschungsfragen sich bei der Konzeption und Entwicklung eines mobilen Stadtführers für das Finden und Nutzen touristischer und kultureller Sehenswürdigkeiten ergeben. Hierbei werden verschiedene Schwerpunkte gesetzt. Technische Fragen zu den Multimediafähigkeiten der aktuellen mobilen Endgeräte, den geeigneten Programmiersprachen und Technologien, zur dynamischen Generierung von digitalen Kartenausschnitten oder einer geeigneten Positionsermittlung des Benutzers müssen beantwortet werden. Vor dem Hintergrund der Konferenzschwerpunkte werden aber die Forschungsergebnisse vor allem am Beispiel der Funktionalitäten eines implementierten Prototyps erläutert.

Abstract:
This paper demonstrates which research questions arise for the conception and development of a mobile city guide for locating and describing tourist and cultural attractions. In this connection different points are emphasized. Technical questions about the multimedia capabilities of current mobile devices, suitable programming languages and technologies, the dynamic generation of digital maps or adequate positioning technologies have to be answered. Against the background of the focal points of the conference, the research results are especially demonstrated with help of the functionalities of an implemented prototype.

Introduction:
The ongoing competition within the tourism sector demands new ideas for the presentation of tourist destinations and places of cultural interest. Mobile devices are becoming increasingly more powerful and companies from the telecommunications sector are fully supporting the integration of mobile devices into peoples' everyday lives. The high data transfer rates now available mean that the introduction and distribution of wireless network technologies and multimedia applications have higher expectations imposed upon them. Interviews and early applications in this research area have shown that location based services, which are usable and of added value, are being accepted by the tourist target group. Thus, interesting possibilities arise for cultural institutions to inform the public about themselves and their activities. While the first mobile information systems were relatively simple, text based and not very interactive, new chances to enhance the user experience are created with the rapid technological advances. Higher degrees of automation and the provision for personal and context-based parameters allow the development of mobile information systems which adapt to the interests and likes or dislikes of the users.

A prototype of a mobile information system for Prague was developed, which can be accessed from different mobile devices. It allows the retrieval of general city information and multilingual and multimedia information about Points Of Interests (POI), e.g. places of cultural interest and museums. The city information system is also capable of integrating 3rd-party-services, like weather information and time tables for public transportation. The map functionality is incredibly

important. It not only allows for personal navigation, but also integrates functionality for the search and information display of POI and events. The user can detect her or his position via GPS. Integrated route and tour functionality helps tourists to visit Prague, whilst being directed by the mobile city guide. A multi user modus allows the visualization of people on the segments of the map and a synchronous exchange of positioning information, including meeting points and messages. Such a system would complement printed travel guides, making sightseeing a city much easier.

Related work

There are several related research projects that deal with tourist information on mobile devices, including LoVEUS, Mobile Deep Map, daMobile system, TellMaris, CRUMPET and GEIST. An analysis of those systems allowed to arrive at a conclusion for the later system design and functionality. To draw a comparison a criteria catalogue was developed, which was divided into four parts (general, technical, design- and usability plus textual aspects). Positive characteristics of such a system can be subsumed from this.

In a nutshell, a mobile city guide for tourist information is **technically** made up of:

- A client-server architecture of the system, because limited resources of the mobile device can be used in an optimal way and computationally intensive operations can be shifted to the server.
- A modular and service-oriented architecture which allows the distribution of content in an optimal format for the clients.
- A portable client application which is executable on different devices.
- A positioning technology, which meets the demands (accuracy of about 10 - 30 m).
- Deployment of wireless network technologies (e.g. 3G) with high data transfer rates to be able to transport multimedia data from the server to the clients.
- Dynamic generation of adaptive maps in a vector format which promises smaller data sizes and a better quality than bitmaps.
- Integration of a routing component for the assistance of different transportation routes.
- Embedment of a payment system which allows discounting of singular services.
- The usage of technical standards.

Important **design-related** requirements are:

- A reasonable sub-division of the graphical user interface (GUI) and a consequent menu navigation and design which increases the usability of the application.
- An adequate visualization, generalization and perspective of the maps.
- Consideration of multimodal user interfaces which eases human computer interaction (HCI).
- Integration of help functionality.
- Scalability of the GUI for different mobile devices.

Textually the conceived system should:

- Focus on tourists as the target group.
- Offer satisfying, up-to-date and personalized information.
- Keep ready general city information and information about events within the city.
- Display POI, events and humans on the maps and offer additional information.
- Be open for the integration of 3rd-party services.
- Recommend tours and integrate easy-to-use routing functionalities.
- Incorporate context-based parameters.
- Allow the application of multimedia.
- Provide multilingualism and ensure a high interactivity of the map functionality.

Requirements analysis

This list above represents the positive characteristics which make up a mobile city guide for tourists. But fundamentally, the user and his needs should always be within the focus of considerations during software development. Demand-oriented software development ensures that the individual demands of a user correspond with the implemented functionalities. The wishes of a potential user can be detected in a requirements analysis. Precondition is the identification and description of relevant user groups. For chosen user groups activities as well as spatial and temporal parameters of the requirements analysis can be identified and target definitions may be put up for the information system. The target group for this work were tourists. They can be differentiated into individuals or groups of tourists. In the scope of this paper an emphasis is put on individual tourists, who have arrived at their destination. Users can be distinguished based on the following factors: age, interests, nationalities, educational background, knowledge of the city and experience with mobile devices. The goal of this work isn't the consideration of every user group. The time frame didn't allow this. Instead two user groups were chosen. First of all, "students, young people". A certain level of experience with mobile devices can be assumed. They are open-minded towards technological advances and posses a certain buying power. Also, the target group "family" was chosen. A family normally consists of members of different ages. Interests, educational background and experience with mobile devices can heavily vary. Thus, different individual wishes and demands can be assumed. On the other side family specific demands, e.g. family-oriented restaurants, hotels and leisure activities have to be taken into account during the conception. An optimal system would commit itself adaptively towards the demands of the users and the context of usage. Here's a use case for the user group "family" – an analysis of the activities helps to set up a definition of goals for the reference-system.

Use case "Family"

The British couple Leah (40) and Thomas (45) has arrived with their daughter Monica (15) and her friend Jessica (16) in their hotel "To the yellow shoe", in Prague. Now, they want to get an overview of the city and see the most important sights of the Oldtown. For this purpose, the family uses a mobile city guide on their PDA with a GPS-receiver. After a couple of clicks, they get to know important historical details of Prague, which have been prepared multimedia-based. Short texts, pictures, animations and videos are available. Under another menu item they learn that Prague has been divided into different areas for better navigation. Upon a click on the Oldtown they can find the location on an interactive map. With other clicks on the icons, the family can access important short information, like name address and opening hours. Additionally, more multimedia presentations about the most important sights are available. In a menu for tour recommendations, the family chooses the "Getting acquainted tour", which presents the most important sights of Prague. They start their tour by foot and the PDA shows them the way to the sights. They can track at any time, where they are and when and where they have to turn off into which street. After the tour is over, they find the closest family-oriented Italian restaurant on the map of their PDA. With one click they are able to reserve a free table in the restaurant "Grassetto", the PDA then displays the route to the Italian restaurant. During dinner, the family decides to separate, later. The parents want to make an additional tour for art lovers, the girls want to go to the shopping mall "Flora", which they've found on the digital map. According to an advertisement of the fashion store "Diesel Store" there are cheap jeans on sale. Thomas passes over a second PDA to them and arranges a meeting point with them on the map at the national museum. The family separates. After 2 hours, Thomas gets a short message from his daughter, that they've found other interesting stores. They would like to come 30 minutes later than agreed. The father writes back, that it's ok and sends her the coordinates for a new meeting point at Oldtown Square at 18:00. Monica and Jessica are being directed comfortably by the PDA and get together with their parents at the agreed meeting point.

The use case above contains many context-based parameters, like activities, places, times, persons, events, spatial information, used mobile devices and information necessities. For the development of mobile applications it makes sense to sub-divide the use cases into activities and to look at the context of those activities:

*„An activity is a sequence of actions conducted by a human being aimed at achieving a certain objective. This objective could be solving a problem or a task. An action has therefore always an intentional character. Actions are the unit of study of activity theory. An action itself is composed of one or several operations conducted unconsciously. Actions are planned by human beings to change a situation or an object to achieve the intended goal. In mobile situations user goals could be orientation, finding persons or objects, finding the way to an object etc. An action can become an operation by learning (routine) or can become an activity. Another important aspect of human activities is the fact that they are always embedded in a context. This context is shaping the activity and vice-versa. "[*Reic03, p. 1312*]*

An analysis of the activities and other parameters contained in the use cases leads to the following:

Context analysis of the use case "Family"
The context of the particular activities is: *find* general city information, *identify* city information, *localize* sights, *identify* sights, *search* for tours, *identify* chosen tours, *navigate* to sights, *identify* sights, *search* for family-oriented Italian restaurants, *identify* restaurant, *navigate* to restaurant
Parents: *search* for tour, *identify* chosen tour, *localize* meeting point, *navigate* to sights, *check* message of daughter, *search* for meeting point, *navigate* to meeting point
Daughter and friend: *search* for fashion store, *identify* fashion store, *navigate* to fashion store, *check* possibility for later meeting point, *navigate* to meeting point

The context analyses showed that the mobile city guide had to contain fundamental functionality for identifying general and up-to-date city information for Prague. Additionally, information for different POI and events had to be kept ready, which can be searched for, sorted, and localized using different criteria (distance, quality, "family-oriented", "Italian restaurant"). Also, a positioning of the user and other users met the demands. The system also had to integrate and visualize routes and tours. Another necessity was the possibility to exchange messages, meeting points and routes between the users.

System design
The figure below shows a simplified architecture of the developed system. The components needed for the middle tier are being distributed over 3 servers: A route server, a map server and an application server. Smart clients access their various functionality over standardized interfaces.

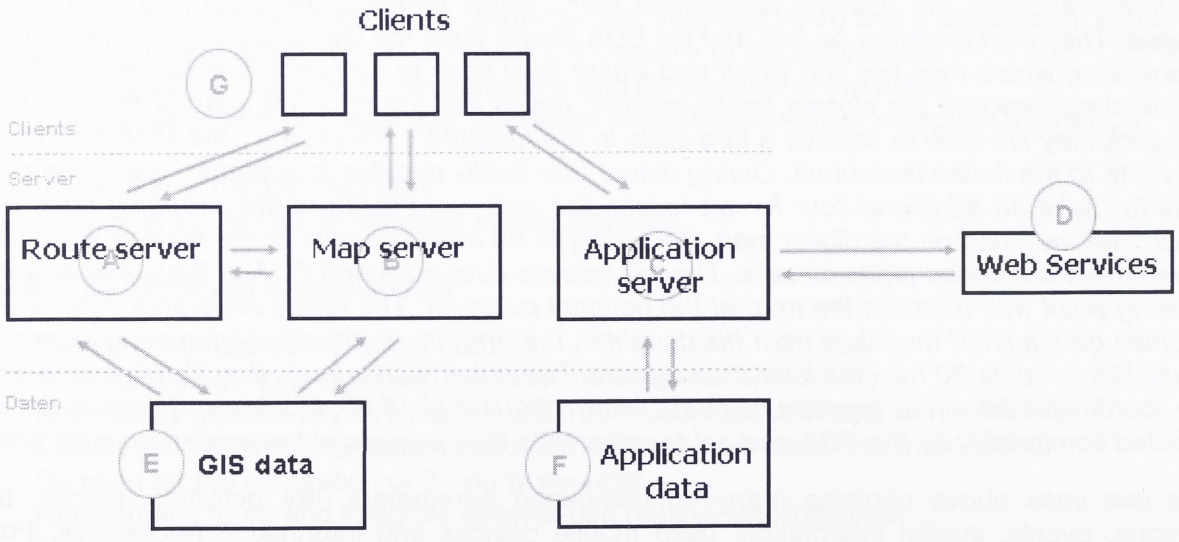

Fig. 1: Simplified system architecture

The **route server (A)** enables the calculation of routes and uses **Geographic Information System (GIS) data (E)** therefore. The **map server (B)** generates map segments. Here for the map server also needs access to the GIS data. All other server side functionalities are being realized as a web application in an **application server (C)**. For the processing of multimedia content and user administration the application server has to have access to **application data (F)**. The application server also acts as a proxy server for web services by accepting client requests to **web services (D)** and passing back responses in an optimal format for the clients. To enable platform independence and connect different mobile devices over various protocols a service-oriented architecture (SOA) was chosen. Thus the application could be broken down into several services which may be addressed by different **clients (G)**.

Parts of the digital reference map of Prague in the shapefile format (SHP) were available for the areas Prague 1 and 2. In a geodetic date transformation they were projected from the national Jednotnou Trigonometrickou Sietou Katastralnou (JTSK) reference frame into the World Geodetic System 1984 (WGS-84) reference frame. WGS-84 is the foundation of most 3-dimensional reference frames within traffic systems, like GPS. Thus, positioning visualization of objects and persons is possible on digital maps in WGS-84-date. Reference devices for the practical implementation were a Smartphone (Nokia 6600) and a Pocket PC (HP IPAQ 4150). For a GPS-localization on the Pocket PC a Fortuna Bluetooth GPS-receiver was used, which can be connected to the Pocket PC via Bluetooth.

Demonstration

After a successful login or registration the user accesses the start menu in the chosen language. Here, she or he can choose from the menu items "Buddies", "Guide", "Map", "Mail", "Search", "Help", "Contact", "Settings" and "More". Fig. 3 demonstrates the map functionality. The different layers are being visualized through the use of meaningful colors and generalization. The segments of the map can be enlarged or minimized over two buttons. Panning is achieved on the Pocket PC via a small click with the stylus pen on the display. The relevant area is then positioned centrally. The top menu allows navigation to other functionality, like editing displayed layers, address search and so on.

Fig. 2: Start menu

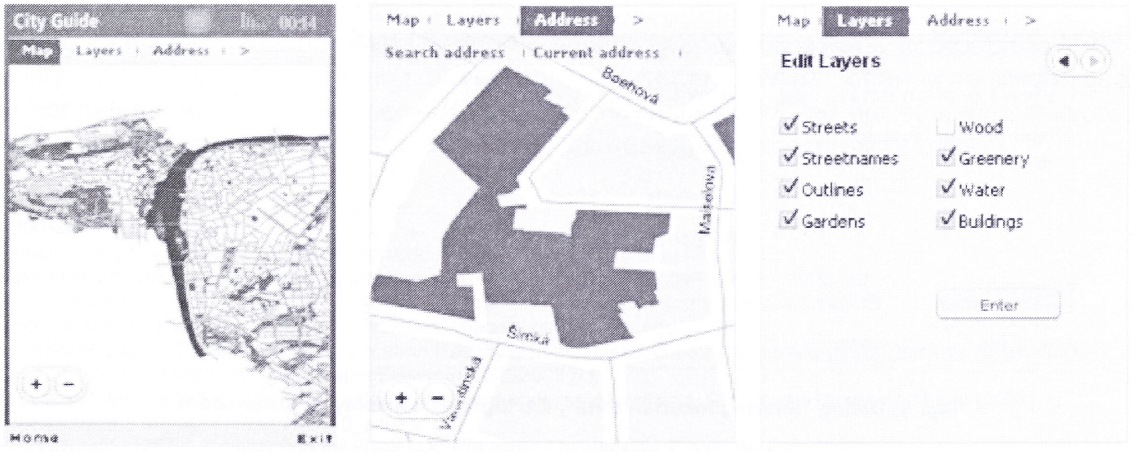

Fig. 3: Map

Beginning with a certain zoom level POI are displayed on the map visualized by an icon for each category. Within the detailed view, a picture, the name of the POI and describing icons are shown. In the example below these are icons for public transportation and the number of the tram line.

Depending on the specific POI additional icons are provided, including: air condition, children, e-mail, fax, internet, fitness, nice view, live music, subway, no photos, smoking allowed, no smoking, swimming pool, telephone, TV, train, vegetarian and so on. Furthermore, additional information is available about the media associated with the POI plus a describing text. Media elements are also subdivided into different categories. Videos and audio files can be played back and also pictures and animations may be displayed.

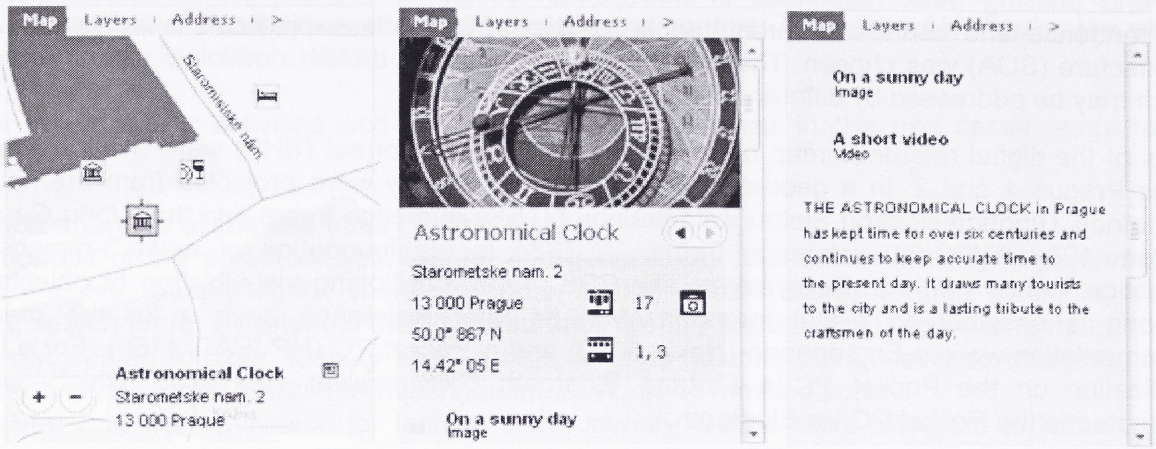

Fig. 4: Point of Interest

GPS-Location data can be exchanged synchronously between users of the system. Security mechanisms prevent that unauthorized access takes place. A user is always informed if another user wants to access current personal positioning data. The pop-up windows in Fig. 5 show the dialog between father and daughter from the use case "Family" described earlier. On the right hand side the position of the daughter ("Jessica") is being displayed by a cross-hair. The big cross-hair shows the current position of the father.

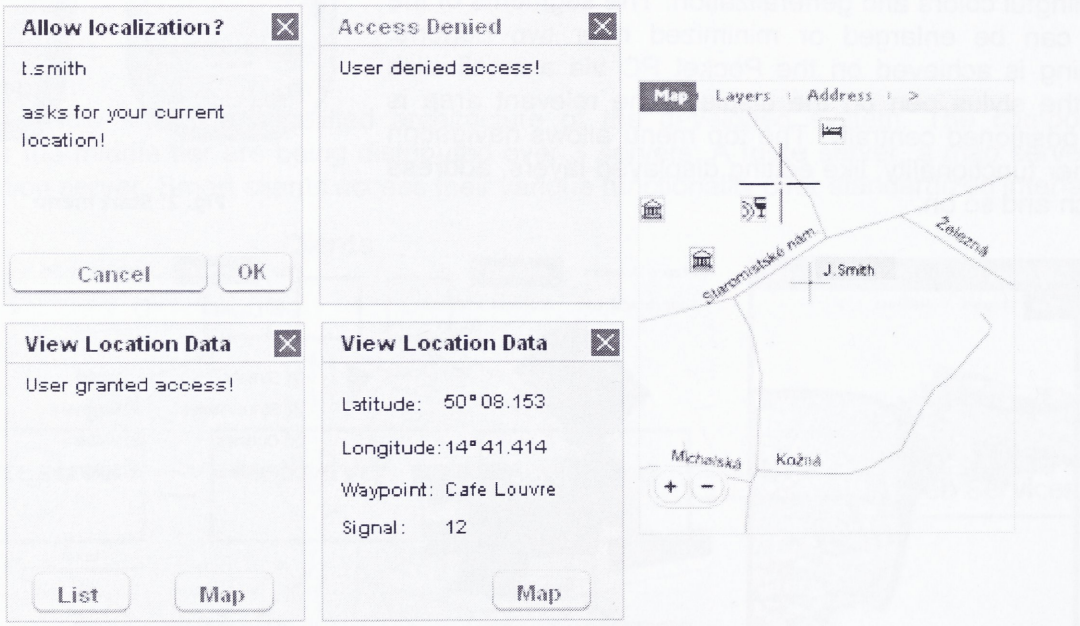

Fig. 5: Dialog "Sharing location data", Cartographic display of other users

Outlook

This paper presented the conception of a mobile city guide and described the implementation of a functional prototype. A future goal might be the development of additional interactive, map-based and location-aware services for mobile devices that assist users as they engage in time-critical and

goal-driven tasks. An example for possible areas of application could be map-based multi-user services containing multimedia elements. Further research should compare the pros and cons of the server side and dynamic generation of multimedia content, Remote Method Invocation, XML-feeds and Web Services. Server side generation of dynamic content - in combination with metadata describing the content semantically - could allow extreme personalization of mobile services. Together with a thorough analysis of the requirements and with respect to context-based parameters this seems to be key to a successful adaptive system. Interestingly, the collection and storage of personal and positioning data seems to be a condition for successful mobile services, which is in conflict with the need for data security of an individual. Additionally, there has to be further study into the presentation techniques of multimedia content on mobile devices. Ideally the user shouldn't actively search for adequate content, but the information should find him. Still, most of the current services are relatively simple and limited by the input-output-capabilities of mobile devices. Higher degrees of automation and adaptation to context-based parameters are required to move beyond these simple services and to target the personal demands of a user. The conventional request-response model doesn't seem to meet the demands anymore, since it's not "smart" enough. Within the research group INKA at the FHTW Berlin, a mobile broker platform is currently being developed. The mobile broker is responsible for automatically recommending and distributing mobile services to a user she or he could potentially be interested in. This process takes into account the context within which a user operates - e.g. the location, personal interests and dislikes, the activity a user engages in, who his friends and colleagues are and other contextual parameters. There are currently several methods available for localizing mobile devices (GPS, A-GPS, E-OTD, CGI+TA, UL-TOA, etc). Personal preferences can be determined explicitly or implicitly in a self-learning system. Human activities are always embedded in a context and can be extracted in a context analysis as presented. The new prototype implements functionality for adding new services to the system with the help of a registry. Services are described in an ontology, which provides the necessary background knowledge about the service and its content (ID, name, author, position, vendor, time, type, language, category, etc.) and include ratings of the service by other users. One of the most promising technologies to produce high quality recommendations is Collaborative Filtering, which is best known for its use on e-commerce websites. Collaborative Filtering works by generating recommendations based on a few users who are most similar to the user (nearest neighbours). A user is represented as an N-dimensional vector of items, where N is the number of catalog items. Similarities between users can be measured in various ways. Common methods are measuring the cosine of the angle btw. two vectors or computing the Pearson correlation. The integration of semantic similarities for items with rating- or usage-based similarities allows to make conclusions on why a user may or may not be interested in a particular item. In cases where little or no rating/usage information is available, the system can still use the semantic similarities to provide reasonable recommendations for users. Enhancing item-based collaborative filtering semantically could be a good approach to improve the scalability of collaborative filtering algorithms in general while offering a high quality of recommendations at the same time. Adapted to the mobile world and our scenario, this could also be a good approach to recommend mobile services based on the context of usage.

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