A Light-weight Framework for Location-based Services

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1   Motivation

Context-aware mobile systems aim at delivering information and services tailored to the current user's situation [1], [10]. One major application area of these systems is the tourism domain, assisting tourists especially during their vacation through location-based services (LBS) [4], [7]. Consequently a proliferation of approaches [2], [5], [8], [9], [12], [15], [17], [18] can be observed, whereby an in-depth study of related work has shown that some of these existing mobile tourism information systems exhibit few limitations [3], [19]: First, existing approaches often use proprietary interfaces to other systems (e.g. a Geographic Information System – GIS), and employ their own data repositories, thus falling short in portability and having to deal with time consuming content maintenance. Second, often thick clients are used that may lack out-of-the-box-usage. Third, existing solutions are sometimes inflexible concerning configuration capabilities of the system. To deal with those deficiencies, we present a lightweight framework for LBS that can be used for various application domains. This framework builds on existing GIS standards, incorporates already available Web content, can be employed out-of-the-box, and is configurable by using a Web-based interface. The applicability of the framework is demonstrated by means of a prototype of a mobile tourist guide.

2   Basic Features of our Framework

In the following a brief overview of the basic features of our framework is given.

Support for LBS. Our framework supports the creation of LBS tailored to the user's position and preferences for arbitrary application domains, e.g. tourism or infrastructure management. The user is provided with a map of his/her surroundings together with points of interests (POIs) and the current position based on GPS.

Integration of external data-sources. Integration of existing external data sources is enabled by incorporating existing GIS servers as well as by augmenting the POIs with existing Web content (cf. e.g. [11], [14]).

Exploitation of GIS standards. Our framework uses the open OGC Web Map Service (WMS) standard [13] for retrieving geospatial information in form of maps.

Application of a thin client approach. A thin client approach is employed allowing to run the application out-of-the-box. On the client side only a graphical, ActiveX enabled browser, an Internet connection and a GPS sensor is required.

Configuration of external content inclusion. Our framework offers the possibility of configuring the inclusion of external Web content through a Web-based interface. First, POIs can be added, deleted and updated in the framework's repository (cf. Section 4). Second, for each POI a title, the geographical coordinates and an URL pointing to external Web content describing the POI, can be configured. Third, POIs can be assigned to possibly nested categories, thus forming thematic layers such as

gastronomy including the sub categories of cafes, fast food, and bars. Forth, for each category the visualization of the corresponding POIs can be chosen.

Configuration of external GIS inclusion. In addition to configuring the inclusion of the external content in terms of POIs, the WMS request to the external GIS server can be configured again through a Web-based interface. This comprises the URL of the GIS server, the type of map (e.g. aerial photography), which area to retrieve (in terms of coordinates), the spatial reference system (e.g. Gauss-Krüger), the desired output format (i.e. JPEG, GIF, PNG or SVG) and the output size of the map in pixels.

3 Functionality of our Framework

The main functionality provided for the user is described in the following. A screen shot of the system's graphical user interface is depicted in Fig. 1.

Basic map functionality. Basic map functionality like panning, selecting or changing the zoom level are supported and the user can switch between a street map and an aerial photo.

Selection of thematic layers. The user can select different thematic layers he/she is interested in. The corresponding set of POIs including those POIs associated with sub-categories is then superimposed on the map through pictograms at each user request, thus enabling the user to build a topographical mental model of his/her surrounding (cf. Fig. 2a).

Fig 1. User Functionality

Information about POIs. POI pictograms indicate whether by clicking on them further information, e.g. historic information or pictures can be requested (cf. Fig. 2b).

Search of POIs. The user is able to search POIs by indicating a thematic layer and a certain distance as search radius. Based on this information and the current user's position, POIs are filtered and displayed accordingly.
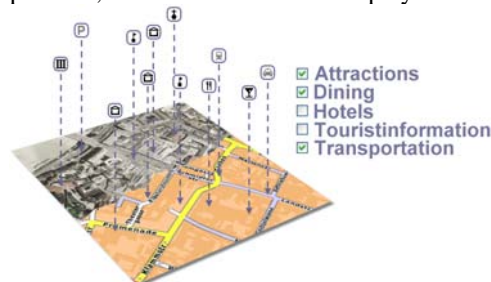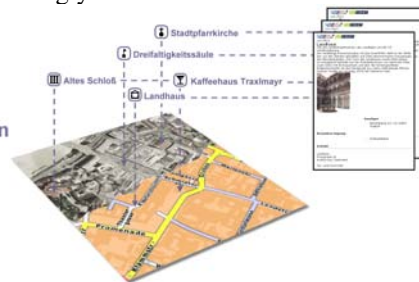

Fig 2a. Thematic Layers   **Fig 2b.** Inclusion of External Web

Refresh of maps. The displayed map is refreshed automatically either as soon as the user performs an explicit action, e.g. panning the map or periodically to reflect the movement of the user. The refreshing period can be adjusted to the user's speed.

Visualization of current position. Getting a valid GPS signal in the historical parts of a city is a commonly known problem, due to the alleyways, which block signals of satellites located near the horizon. Unavailability and changing accuracy is

dealt with in the following way: First, we use a circle as the symbol to represent the uncertainty of the user's current position. Second, the user is continuously informed about the quality of the received GPS signal. Third, in the absence of a GPS signal, the centre of the currently displayed map is assumed to be the user's current position.

Collaboration functionality. Since social factors are important in several application domains of LBS, some basic collaboration functionality is provided. First, POIs provide a link to a guestbook allowing users to annotate POIs (e.g. in the tourism domain rating the quality of a restaurant), that can be shared with other users. Second, the system offers the visualization of other users simultaneously using the system, thus providing the prerequisite for subsequent interaction.

4   Architecture of our Framework

The client/server architecture of our framework consists of internal components in terms of a *LBS Engine* and a *Repository* (cf. Fig. 3). The LBS engine is implemented using JSP and Java Beans and realizes the framework's core functionality. The repository utilizes a database for storing configuration information. External components comprise a *GIS Server* and external *Web Servers* to deliver further information about POIs. On each request the system performs the following six steps:

Fig 3. Architecture

**Step 1:** The Web Browser communicates with the Web Server over WLAN and is continuously informed about the user's location through an ActiveX component included in the corresponding HTML-page. As the user invokes actions, e.g. clicking on a POI, a request with the GPS data as additional parameter is sent to the Web Server and forwarded to the LBS Engine processing.

Step 2 and 3: Corresponding to the user's position and kind of request, the LBS Engine retrieves from the Repository the WMS parameters and requests geo-data from the GIS Server using the OGC WMS specific *Get Map Request*. The GIS Server processes the request and returns an image based on those parameters.

Step 4: Before being deployed to the Web Browser, the map image is, based on the user's preferences and location, augmented with information about POIs retrieved from the Repository. The POIs' geographical coordinates are transformed into pictures' pixel coordinates to correctly locate the POI pictograms on-top of the map.

Step 5: The user receives the image in form of a MIME-type encoded picture, which contains the map and thematic layers.

Step 6: When the user requests further information of a specific POI, the corresponding Web page is retrieved from the appropriate external Web Server.
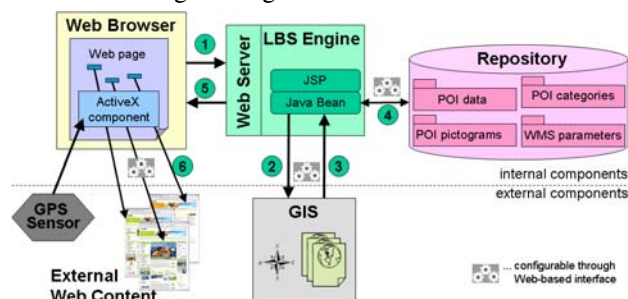
5   Prototypical Application – Linzer Mobile Guide (LiMoG)

The applicability of our framework is demonstrated by realizing a tourist guide for the city of Linz called LiMoG - short for Linzer Mobile Guide. The configured POIs

include, e.g., historic sights, churches and cafes along traditional sightseeing tours through the historic centre of Linz. DORIS [6], the GIS of the federal state of Upper Austria, provides the geospatial data in form of an OGC WMS. Each POI links to a certain existing Web page provided by Austria's official destination information and booking system TIScover[16], [20]. For example in case of a restaurant, TIScover provides information about facilities, cuisine, opening hours, prices as well as photos. For demonstration purposes, we used a Pocket PC (IPAQ 5450) equipped with a GPS receiver (SysOn GPS CF plus II). For accessing the Internet, a publicly available WLAN hotspot in the city centre of Linz was utilized.

6 Outlook

Giving the experience gained we intend to extend the notion of context beyond location and user preferences to consider also other context properties (e.g. time, network) as well as a combination thereof. To increase flexibility of the content incorporated, an adaptation component is envisioned, which can transform the content before being displayed to the user (cf. [10]).

References

[1] Altmann, J. et al.: Context-Awareness on Mobile Devices - the Hydrogen Approach, Proc. of the 36th Hawaii Int. Conf. on System Sciences, Hawaii, 2003
[2] Anegg, H. et al.: Designing a Location Based UMTS Application, Springer, 2002
[3] Baus, J. et al.: A Survey of Map-based Mobile Guides. In Liqiu Meng and Alexander Zipf (eds.): "Map-based mobile services – Theories, Methods and Implementations". Springer, 2005
[4] Berger, S., Lehmann, H., Lehner, F.: Location-based Services in the tourist industry, International Journal on Information Technology & Tourism, Cognizant, 5/4, 2003
[5] Cheverst, K. et al.: Developing a context-aware electronic tourist guide: some issues and experiences, Proc. of the SIGCHI Conference on Human Factors in Comp. Systems, The Netherlands, 2002
[6] DORIS, Digitales Oberösterreichisches Raum-Informations-System, http://doris.ooe.gv.at.
[7] Garzotto, F. et als.: Ubiquitous Access to Cultural Tourism Portals, Proc. of the Int. Workshop on Presenting and Exploring Heritage on the Web (PEH), Spain, 2004
[8] Hinze, A., Voisard, A.: Location- and Time-based Information Delivery in Tourism, Proc. of the 8th Symposium on spatio-temporal databases, Santorini Island, Greece, 2003
[9] Kamar, A.: Mobile Tourist Guide (m-ToGuide). Deliverable 1.4, Final Report, 2003
[10] Kappel, G. et al.: Customisation for Ubiquitous Web Applications - A Comparison of Approaches. Int. Journal of Web Engineering and Technology, Inderscience Publishers, 2003
[11] Kapsammer, E. et al.: Bridging Relational Databases to Context-Aware Services, Proc. of the CAiSE Workshop Ubiquitous Mobile Information and Collaboration Systems, Portugal, 2005
[12] Krösche, J. et al.: MobiDENK-Mobile Multimedia in Monument Conservation. IEEE MultiMedia, 11/2, 2004
[13] OGC. Open Geospatial Consortium. http://www.opengeospatial.org.
[14] Pashtan, A. et al.: Personal Service Areas for Mobile Web Applications. IEEE Internet Comp. 8/6, 2004
[15] Poslad, S. et al.: CRUMPET: Creation of User-Friendly Mobile Services Personalised for Tourism. In: 2nd Int. Conf. on 3G Mobile Communication Technologies, UK, 2001
[16] Pröll, B., Retschitzegger, W.: Discovering Next-Generation Tourism Information Systems - A Tour on TIScover, Journal of Travel Research, Sage Publications, Inc., Vol. 39/2, 2000
[17] Roth J.: Context-Aware Web Applications Using the PinPoint. IADIS International Conference WWW/Internet, Portugal, IADIS Press, 2002
[18] van Setten, M., Pokraev, S., Koolwaaij J.: Context-Aware Recommendations in the Mobile Tourist Application COMPASS. Proc. of 3rd Int. Conf. on Adaptive Hypermedia and Adaptive Web-Based Systems, The Netherlands, Springer, 2004
[19] Schwinger, W. et al.: Context-Awareness in Mobile Tourism Guides – A Comprehensive Survey. Technical Report, Johannes Kepler University Linz, IFS/TK, 2005
[20] TIScover Destination Management System, http://www.tiscover.com.