User-Adaptive Maps for Location-Based Services (LBS) for Tourism

Alexander Zipf

European Media Laboratory – EML, Heidelberg, Germany
alexander.zipf@eml.villa-bosch.de

Abstract

Producing interactive maps for internet applications in tourism has become widespread. But they are often quite simple in terms of adaptation to the user or context. We argue that it is not enough to focus on adaptions to technical parameters (device characteristics, QoS, location, …), but propose that tourist maps need to be dynamically generated according to a wider range of variables from user preferences and interests, the given task, cultural aspects to communicative goals and actual context and location. This means that a system that is able to generate such maps needs to exploit user models and context knowledge. Within this paper, we focus on two aspects of LBS, i.e., using the spatial and personal context for proactive tips and generating personalised maps, by presenting an overview about posible parameters and propose a model for adaptive map generation and give examples of first prototypical realizations.

Keywords: mobile tourism services, personalisation, map adaptation, GIS, focus maps

1. Issues: Personalised Location-based Services (LBS) for Tourism

3G wireless networks will enable new forms of mobile services. Location Based Services (LBS) are such services for mobile users that take the current position of the user into account when performing their task. For LBS, map information and GIS services and infrastructures are crucial helper services. LBS applications for tourism range from tour planning, navigation support to yellow page services and m-commerce [Zipf and Malaka 2001]. Producing interactive maps for internet applications in tourism has become widespread. But they are often quite simple in terms of adaptation to the user or context. We argue that it is not enough to focus on adaptions to technical parameters (device characteristics, QoS, location, …), but propose that maps need to be dynamically generated according to a wider range of variables from user preferences and interests, the given task, cultural aspects to communicative goals and actual context and location. This results in a large number of factors influencing the design of a tourist map. Within the EU IST project CRUMPET, which is aiming at the "Creation of User-friendly Mobile Services Personalised for Tourism" [Poslad *et al*. 2001], first steps towards user specific tourism maps are being realised. Thus, the LBS being developed are not only location-aware but also personalised. This means they will exploit user models and context knowledge [Malaka and Zipf 2000]. In this paper, we focus on two aspects of LBS, i.e., using the spatial and personal context for proactive tips and generating personalised maps. Such smart behaviour is being realised using intelligent agents as explained in another paper submitted to this conference [Schmidt-Belz *et al*. 2001]

2. Spatial Context & Proactive Tips

To realize LBS that can interpret the spatial context of the user intelligently a module is needed that converts between the different possibilities of representing spatial information. First, a conversion from adresses to coordinates (Geometric Representations), called "geo-coding" is necessary; the vice versa taks is necessary anyway in any clickable map service. The user of the CRUMPET system will have the option to enable the pro-active Spatial Context Agent. This agent can draw the user's attention to objects of interest that are near-by. The tip will be given in a non-intrusive way, as experiences with proactive approaches have shown that acceptance is otherwise quite low. In order to deliver personalised location-aware tips for tourists, the spatial context agent needs to be aware of the user's position, the location of objects as well as the user's interests. The decision what “near-by” means for the user in the current situation has also to take into account a range of personal and contextual parameters. Additionally the Spatial Context Agent shall support the proactive provision of tips if a user is close to a sight, region or object he might be interested in. Buildings suitable for acting as landmarks should be priorised, i.e. if the user is reasonable close to a church or a restaurant it might be more suitable to return the adress and name of this building instead of explaining to the user that she is closest to “Main Street 348”, which is a not easily to recognize building. To gain the relevant contextual information the Spatial Context Agent (SCA) has to get information from the following agents:

1. The User Model Agent provides detailed information on the current users interests.
2. The Spatial Agent identifies all the object in a region near the actual user location.
3. The DB Agent has the taxonomic information on the identified object.

One of the endogenous variables the SCA has to determine is the area which should be defined close to the user. In the first prototype of the SCA this region is a fixed polygon directed towards the user’s walking direction, which is derived from the position tracking history. More sophisticated parameters that might determine what the user means with "near" objects are given below. Defining such “near-areas” in a context and user aware way is a research question on its own:

- physical condition of the user
- weather (when it is raining it should probably be closer.)
- task (near might mean something different to the user when he is asking for a closet or for a good outlook or famous sight).
- how good do I know the region (Research on mental maps has shown that perceived distances shrink when the user learns to know the region better).
- structure of the region (flat area with only few houses or complicated setting with confusing number and placement of structures).
- steepness / hight difference (going upwards or downwards).

3. Adaptive Map Services

Maps are of great value for tourists as they have the potential to represent large amounts of information about the area of interest within a single picture in a potentially easily comprehensible form. Examples of where maps are useful for tourists range from walking and navigating in a foreign area, searching for some kind

of business or sight, to general or special information about a region (e.g., on social, economic, historic, environmental, or other aspects). Personal interests of a tourist should also influence the map design. In order to facilitate the correct reading and understanding of a map, it needs to be designed properly. The art to design maps in a way that such condensed information is not confusing but easy to understand has a tradition in cartography. To automate this by using information systems is a challenge for AI, as map design is a complex task involving cognitive and psychological aspects [Barkowsky & Freksa 1997]. Map adaptations for mobile application can and should take into account a wide range of factors, from technical conditions, the cognitive abilities of the recipient, and its purpose of use (e.g. topographic, navigation, thematic, historic map etc.). All these tasks have different requirements regarding the design of the map. While it is important for an overview map to show many features - not necessarily in great detail - a route map especially needs to display suitably important turning points, landmarks etc. [Agrawala and Stolte 2001]. So for each task it is crucial to think about what is to be displayed and what can be omitted or generalized.
In order to personalise maps CRUMPET will exploit a User Model (UM) developed by GMD [Nick 2001] that provides information about the users demographic data (age, nationality...) and interests. Combining this information with the demands emerging from the given task leads to a large number of possible requirements for the design of the map. Thus, it is not very feasible to define a set of (possibly contradicting) rules describing the needed actions to create a user-specific map style. In order to get starting with a working solution, we propose a step-by-step approach.

4. Towards a Framework for Adaptive Map Production

When we come closer to the automatic production of user specific maps, we find that there are different information needs for users with different interests, knowledge of the area and cognitive capabilities (influenced by age, education, physical capabilities). Handicapped persons (e.g. visually impaired people) are a typical example as they require larger symbols and less detail. The latter means that higher zoom level are required (therefore a smaller area is shown). Another example are children as they obviously have different mental capabilities and pre-knowledge. Therefore specific maps for children might need some special properties:

- picturesque easy to understand symbols (not abstract but simplified images (sights))
- perspective or 3D display (closer to reality)
- no abstract information (not being visible in reality like boarders of city districts)
- less information detail, etc.

Further it would be interesting to know how good the user does know the area? This could influences the information detail that is needed to be shown and in particular the amount of descriptive text on the map. Here comes the question of short tem (session-oriented) to long term user model into play - as well as the privacy and security issues associated with that. While we have presented a general discussion about the generation of maps adapted to personal or contextual influences so far, we now want in the next step to develop from these a model that gives a guidline on how to strutre the process of constructing adaptd maps in order to be able to develop a system from these. A first implementation of a system that realizes some of the identified steps will be presented in paragraph 6. The following figure depicts some of the steps that would be needed to adapt a map to the broad range of parameters that have been partially been discused. It does not (and shall not) give details how each processing step is being performed in detail, but acts as framework to identify the needed proesses and gives a first impression of how a more complex design goal could be realized in steps.

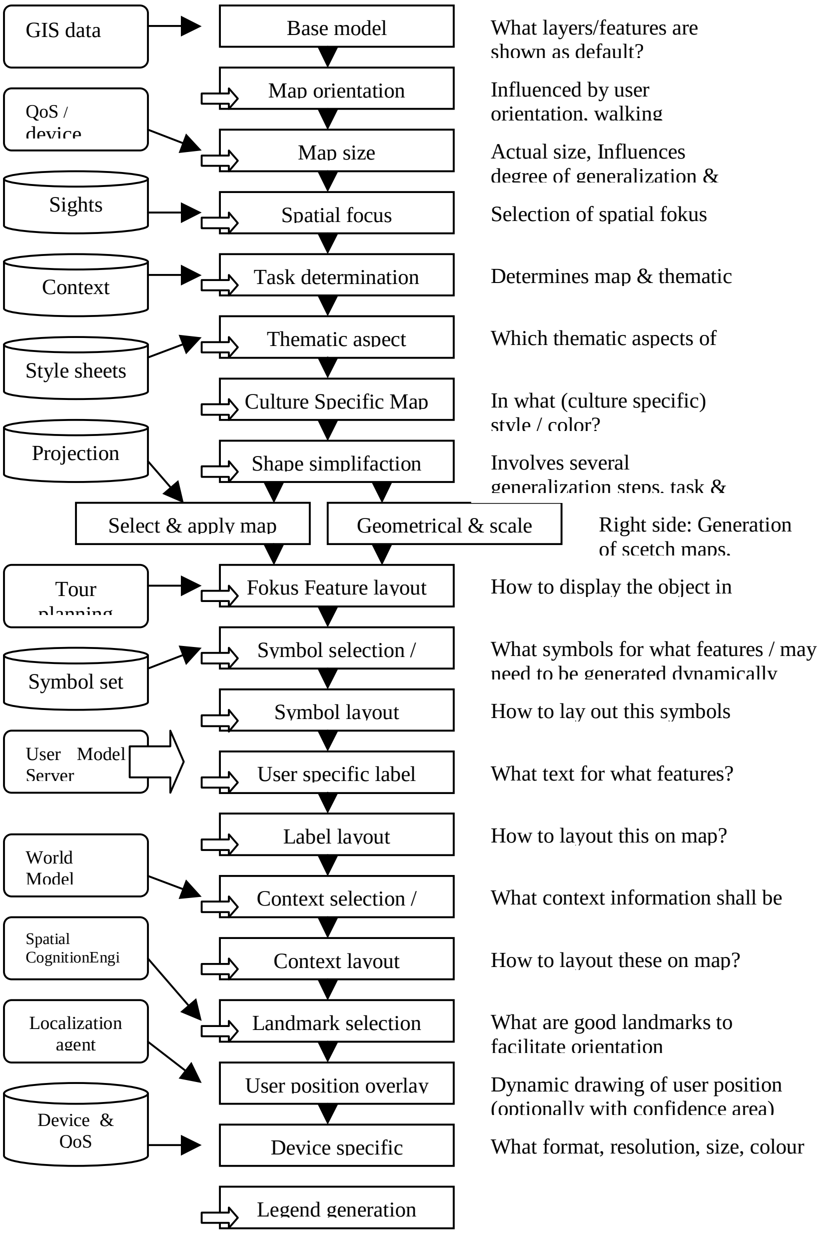

Fig. 1: Design steps for user and context adapted maps

We have not yet realized a system that realizes all of thes steps and parameters, but needed to start with a first step. Therfore we focus here on the influence of culture, task, orientation, generalization and fokus. Some of the other steps need to be done implicetl (base model, device size, labeling, …) but are not dicussed here, others are not yet realized and offer posibilities for further reseach. In the following paragraphs some of the individual aspects realized in prototypes will be discussed.

5. Examples for Map Adaption

5.1 Culture Specific Coloring

There are different official signatures for map features in different countries. These are already familiar from people from different cultures/countries and therefore easier to understand. It is possible to specify different particular map styles for different countries. Right now the only online service doing this (only with respect to color, not other style parameters) is Maporama. The interpretation of colors varies also clearly in different cultures. Therefore one should use colors the user can associate something with. As colors don't have the same meaning in all countries a culture-adaptive map should take this into account:

Table 1: Cultural associations of colors

	Red	***Blue***	***Green***	***Yellow***	***White***
USA	Danger	Manliness,reliability	Safety	Cowardice	Purity
France	Aristocracy	Liberty, peace	Crime	Transitoriness	Neutrality
Egypt	Death	Faith, truth, virtue	Fertility, strength	Joy, luck	Cheerfulness
India	Life, creativity	Fertility,strength	Success	Death, purity	
China	Joy	Heavens, clouds	heaven, clouds	prosperity, trength	Death, purity
Japan	Anger, danger	Schurkerei	youth, energy	Decency, dignity	Death

The Map Service developed in CRUMPET will support different styles, but is being enhanced by allowing modifications to a wide range of graphic properties. Some of the first examples of different map styles for the Heidelberg maps are shown in the following figures. At the moment we have defined map styles for the following nationalities: US, UK, France, Germany, Portugal and Finland, as well some special styles for black-white displays, for traffic maps etc.

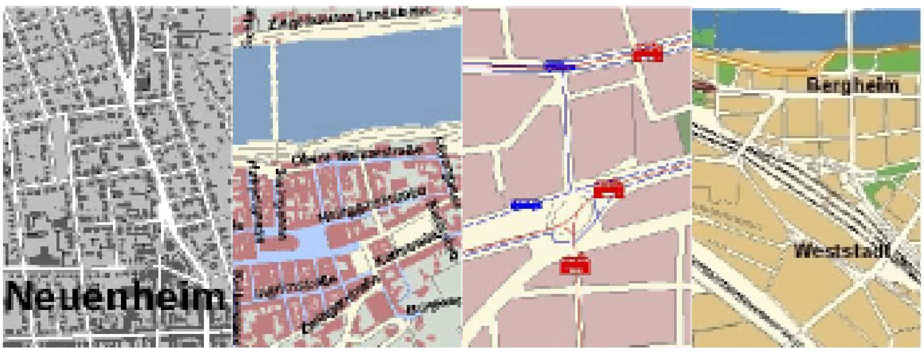

Fig. 2: National and task specific map designs

5.2 Map Generalization

Map generalization is a graphic *AND* content-based simplification of the geographic data using a range of algorithmic or rule based techniques. The necessity for generalization arises from the fact that the representation of reality on a map needs a change of scale. To do this one can apply two principles [Hake und Grüneich 1994], which in turn violate general rules of map making, so compromizes are needed:

- *Principle of readability*: draw object larger and in another scale. hurts the principle of geometric correctness.
- *Ignoring and not drawing certain features*: hurts he principle of completeness

These principles lead to a range of strategies for generalizing maps:

- Simplifying
- Replacing
- Selecting
- Extending
- Summarizing
- Judging
- Classifying
- Standardizing
- ..

The current Map Agent is not that sophisticated yet, but allows to specify a degree of generalization for each information layer. Looking at figure 3 one can see the different degree of generalization at different scales using a simple but dynamic generalization algorithm. Further improvements of this are under development.

5.3 User-Orientation Dependent Maps

Another feature that is especially interesting for personalized LBS is the possibility to specify an orientation angle in the map request, indicating where north should be on the map. This allows to produce not only standard maps where north is on the top, as we in the western culture are used to, but to produce maps that are aligned to another direction. This allows it to orient the map in a way that might be easier to interpret by the user in certain situation. E.g. if there is a dominant linear feature, like a big road or river, the map can be oriented in a way that the street is showing in the direction the user is actually walking to.

5.4 Focus Maps

In order to facilitate the reading of maps on mobile devices we propose the idea of "Focus Maps". The graphical representation of these should focus on the important areas and aspects of the map [McEarchen 1995, Freksa 1999]. This means that these are displayed dominantly (for example in more detail than other areas). This shall direct the user's focus to the relevant information. Unnecessary detail should not distract the user's focus. Therefore, less important information should be generalised, but be still accessible.

This effect can be created by e.g. different degrees of generalization (or ommitance) and fading out of colors. We use zones within the map to implement the concept of a Focus Map. This way we can refine the idea of an area of interest. By specficing an inner zone of highest interest and further zones surrounding the inner one it is possible to create an effect of decreasing interest which additionally emphasizes the area of focus. The most inner zone is the most important one, the degree of importance lessens with increasing zone.

Any kind of polygonal shape can be used as a zone, e.g. a buffer polygon around a tour generated by the Tour Agent. This can be seen in figure 3. Currently two kinds of zones are supported.

- Fixed Zones: These zones have a fixed size and center on a real world location. When zooming in the zone stay at the same place.
- Changing Zones: These do not have a fixed size. They always cover a predefined percentage of the area displayed regardless of window scale or size of the window.

The first two maps show examples of changing zones. These zones are always recentered. Thus, the most inner zone is always in the middle of the current view. The third and fourth map show fixed zones.

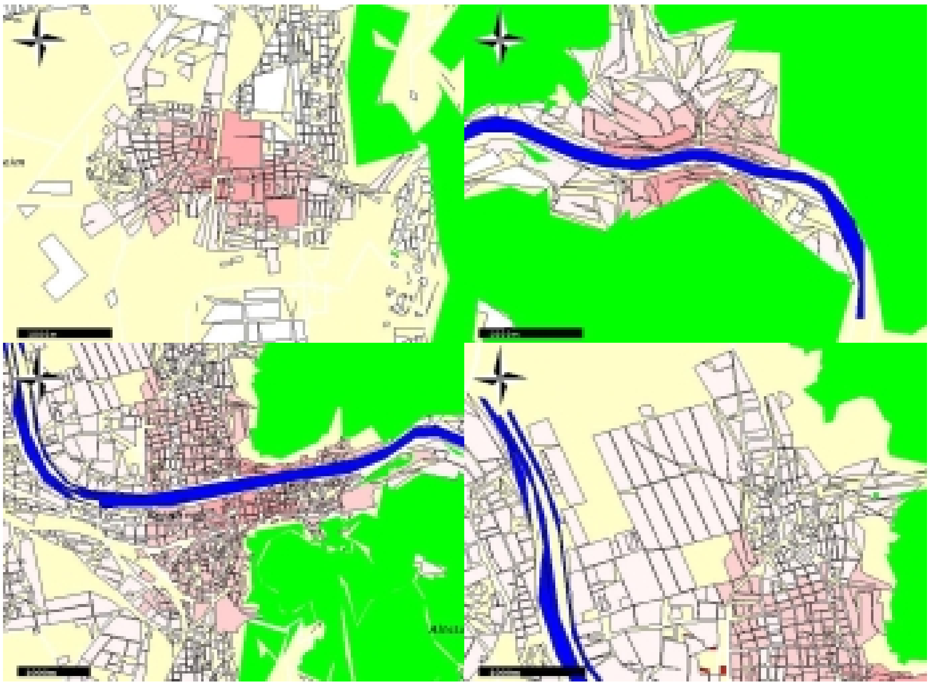

Fig. 3: Examples of Focus Maps (moving and fixed)

The concept can also be exploited in 3D-scenarios for generating VR-worlds that optimize the cognitive effort as well as the amount of data needed for describing the scenes and such saves network bandwidth (Krüger, A. 1999, Zipf and Schilling 2001). Both domains have their own restrictions and need different implementations.

6. An AdaptMap Protoype

The task is to start with a UM and end with a configuration for the MapAgent, represented as a XML file. Additionally, the task the map is used for is given. The UM contains information about a user's home country, her age and her special interests. To realize a system that takes all of these parameters into account when designing a map we propose a step-by-step solution:

1. Get a standard map style according to user's home country
2. Adapt this style to the given task
3. Adapt the style to user's interests

At the moment the Map Server Component can be configured by providing a XML file that describes the map style to be used. This map style is defined ba an XML schema (mapcfg.xsd). Therefore, a user-specific map style must follow this schema, as well.

The user-specific map style is to be created taking into account user-specific data. This data (or user model (UM)) is passed to the module that produces the user-specific map style.

Starting with the user's nationality a standard map style defining the look of all available features is used as first imput. This standard shall ensure that a user gets a map broadly in a design she is used to.

Next, for the actual task given, not all features available need to be displayed usually. Therefore, for different task there exist XML-files that describe which geographic features (map layers) are needed for this particular task. Only these are kept in the natiaonal style as explained. Finally, the map style is adapted to the interests of the user, as well. In principle this is done in the same way as the adaptation to the task.

The map style schema has the following structure:

1. MapStyle: this object contains references (directly or indirectly) to all other objects defining a map style. Additionaly, the map style has a name, a background color and the use of antialiasing can be set. If a Focus Map is to be created, information about the zones is also given here.
2. LayerStyle: It has references to information about the look of the feature layerss in different scales.
3. ScaleStyle: This allows to describe the way the features are to be displayed in a specific scale. The actual look is defined in objects called PointStyle - LineStyle - - AreaStyle - and TextStyle.

All LayerStyles included in the taskstyle are and included in the MapStyle object of the standard style. This way only the layers relevant for the given task are used. At the same time the LayerStyles are adapted to the style defined in the task file. This is done by looking at each ScaleStyle, PointStyle, LineStyle, AreaStyle and TextStyle object referenced by a LayerStyle of the TaskStyle. For all attributes of those objects being set in the TaskStyle the respective attribute of the respective object of the standard style is changed accordingly. Resulting is a map style adapted to the given task. Finally, the map style is adapted to the interests of the user in the same way. All LayerStyles defined in the XML file of an interest are taken and the respective LayerStyles of the style are adapted to their definition. From that MapStyle object an XML configuration file for the MapView-Component can be created in the last step.

7. Conclusion & Further Work

Within this paper we have shown the necessity for this by indicating applications and scenarios for map adaptation to characteristics and interests of the user and context (location/task). We see this as a first step towards building such a more comprehensive model of smart user centric map generation for location based services. The figure shows the individual steps we have identified are necessary in order to design and generate a map dynamically and with consideration of user specifities and context. The actual ordering of taks can vary for specific applications, or some subtaks are exchangeble, as for example projecting a map makes little sense when working with geometrically distorted representations. This model can act as guideline for our future research on adaptive maps by selecting some of the needed submodules and design and realize smart solutions for these. For each of these several techniques can be adopted, which we cannot discuss within this paper. We have identified a range of parameters that need to be adapted to personal interests or context and presented some explicit examples of implementations for map orientation, map generalization, and task and user specific map styles. To illustrate the above we stress that even a simple parameter as “map scale” is depended on properties like: task, information load, the variety of the actual area or cognitive user properties.

In general there is a need for models that clarify which information layer is how important for which task, user group, kind of travel, culture etc.

A research area of its own whose results would help to build better maps is the question of identifying what are good landmarks for a specific user. When identified these should be displayed dominantly to facilitate map reading. Kray does research in that area [Kray and Porzel 2000], and his results will be integrated in future versions of our map agents.

There is still further work needed regarding the presentational aspects, i.e. the way features are to be displayed. But offering focus maps that clearly distinguish between the area that is currently of interest to the user and the part of the map that is not, we believe that the user’s task of reading and interpreting the map is eased. The user instantly focuses on the area that is of interest to her and, thus, saves cognitive work. A first (prototypical) implementation has been realized for the mentioned MapAgent, but further work is needed to evaluate the result and to prove our hypothesis. In order to do that additional integrational work is needed, as well as user trials for getting empirical results. Such trials will be part of one of the work-packages of the CRUMPET project.

Acknowledgements

This work has been undertaken in the context of, and supported by, the EU funded project CRUMPET (IST-1999-20147) and the Klaus-Tschira-Foundation (KTF). We thank all partners for their co-operation. Special thanks go to Kai-Florian Richter and Sebastian Mennicke.

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