OVERCOMING LIMITATIONS OF MOBILE DEVICES

Usability Testing Dynamic Maps

Increasing use of geo-information in "smart phones" and PDAs has led to users being disorientated by map displays on small screens, while outdated maps, storage capacity and processing power further inhibit use. High-bandwidth wireless connections resolve some such limitations but map display remains an impediment to wider use. The authors describe research into dynamic presentation of maps at the desired level of detail.<P>

A user is forced by the small screen of a mobile device into a great deal of panning and zooming to visually link map features to objects in the environment. Since each zoom or pan usually requires complete redrawing of the map the user may mentally lose continuity between previous and refreshed version, and so become disorientated.

UWSM2
A research project was initiated in 2006 to tackle this problem, partially funded by a Netherlands government Space for Geo-Information innovation programme (RGI) and aiming to find solutions for multiple/vario-scale representations of geographic information and interaction via mobile device. Interfaces needed to be context-aware and easy to use in a connected (wireless internet) client-server setting. The project designated "Usable (and well scaled) mobile maps for consumers" (UWSM2) is being executed by a consortium of research and development organisations: (Delft University of Technology, ITC and TNO Defense, Security & Safety), software companies (ESRI and 1Spatial). Representing the end-user are the Municipality of Amsterdam and the Dutch Automobile Association (ANWB). Basically, UWSM2 aims at using advanced online map-retrieval techniques and real-time map generalisation.

Data Transfer
Generalisation is important not only for zooming as an interaction function carried out by users but also because progressive data transfer from server to mobile device improves usability, enabling smooth zooming, that is, initial retrieval of a course map and then additional detail on demand. As a result, map scale may continually change, imitating animation and facilitating the user in seeing where they are. Two scientific challenges addressed are automatic generalisation and human aspects of mobile applications. Part of the research deals with the application of tGAP (topological generalised area portioning) for progressive data transfer. These generalisation concepts will be implemented in a prototype to be developed through User-Centered Design (UCD) techniques. Following investigations with a mobile geo-application comparable to the prototype under development its usability will be evaluated in iterative steps. Methods and techniques of usability testing are currently on the ground.

tGAP Data Structure
Key to solving the problem of user disorientation is gradual variation in scale: "vario-scale" maps. Data structures for representing a fixed number of scale intervals are available but do also store redundant data (same coordinates originating from same source) and support only a limited number of scales. Neither are they suited for progressive data transfer, as each scale interval requires independent graphic representation. The tGAP structure supports vario-scale vector data and enables once-only storage of data without redundancy of geometry, and on-the-fly derivation of different levels of detail concerning the same data. The tGAP structure can produce representations in three formats:
-at any arbitrary scale (single map)
-with feature(s) of interest at larger scale and surrounding features at smaller scales (non-uniform scaled map)
-continuous range, rough to detailed.
Although all three are useful, smooth zooming realised through progressive transfer would seem most promising. To adapt the tGAP structure to the present problem both updating functionality and current DBMS implementation (Figure 4) have to be improved. Of course, it should be possible to implement the theoretical extensions in practice.

Sample Cases
Sample cases suggested by the Municipality of Amsterdam and ANWB involve questions such as where can I park my car and what will it cost, where is the museum, how do I get there and how do I get back to my car? These were combined in a scenario verbally describing possible uses of the system and user tasks, including goals, wishes and context, and provided a starting

point for further specification of functionality by Unified Modeling Language (UML). Use-case models describe frequently executed or complex tasks that might be related or represent an aggregate of “smaller” use-cases. For example, the use-case “store location of car” may be part of the bigger use-case “go to point of interest (POI)”.

Methodology
Since the user concurrently interacts with the device and the environment usability cannot be tested by controlled laboratory experiment alone; field tests are also required. As the research community has little experience so far with field evaluation, part of the project contemplated a methodology for usability testing of a prospective prototype. Special attention was given to the selection of methods and techniques in various combinations. Scrutinising use-cases, interaction models and future prototype functions allowed several user tasks to be defined, including comprehending location by mobile map, searching POIs, receiving online location-based information, presenting route from present location to POI, and textual and graphical navigation assistance. The next step involved converting these user tasks into questions answerable by the system and thus supportive of user decision making. This focused particularly on map scaling to enable assessment of
-clarity, consistency and comprehensibility of map representations at differing scales
-ease in linking map position to environment at all available scales
-helpfulness of mobile application zooming/panning/rotation/orientation functions in terms of understanding map/route.

Assessment
An already existent offline mobile geo-application, iGo My way 2006, was used to assess the proposed usability-testing methodology. Usability criteria such as efficiency, effectiveness and user satisfaction were assessed in variously combined groups by observation, thinking aloud, video/audio recording and semi-structured interview. The results of these tests might be affected by researcher influence on test-subject behaviour and/or by involvement of more than one researcher. For example, the typical video recording is cumbersome to analyse and forces the researcher to continually alternate the aim of the camcorder on mobile device, environment and subject. It too may introduce bias through interference with the test subject. To eliminate these factors a special wireless field observation system was developed and used that enabled one researcher alone to carry out the whole test process whilst minimising subject bias (Figures 5, 6). Environmental conditions such as volume of light, weather and noise were checked during testing. Test subjects representing visitors to an unfamiliar city had to follow a scenario including navigating to POIs along seven routes in a predefined order and within a certain time-span, using zoom, pan, rotation and orientation functions. The experimental methodology, which included a new technical solution for field-based qualitative usability research, gave satisfactory results and may be used for the evaluation of UWSM2 prototypes as well as other similar mobile geo-applications.

Final Remarks
The testing methodology may be advanced by automated analysis of the results or by use of alternative techniques such as post-survey questionnaire, GPS data logging and remote PDA data logging. Once the online prototype of the vario-scale mobile GIS is available the usability-testing environment will be ready for take-off.

Further Reading
- Delikostidis, I., 2007; Methods and Techniques for Field-based Usability Testing of Mobile Geo-applications, MSc thesis, International Institute for Geo-Information Science & Earth Observation (ITC) Enschede, Netherlands, March 2007.

- Elzakker, C.P.J.M van, Oosterom, P.J.M van, and Delikostidis, I., 2007; Testing the Usability of Well-scaled Mobile Maps for Consumers. In Proceedings of the XXIII International Cartographic Conference Congress, 4-10 August 2007, Moscow, Russia (CD-ROM).

- Oosterom, P.J.M. van, 2005, Variable-scale Topological Data Structures Suitable for Progressive Data Transfer: The GAP-face Tree and GAP-edge. Forest Cartography and Geographic Information Science, Vol. 32, No. 4, pp 331-346.

- Oosterom, P.J.M. van, Vries, M. de and Meijers, M., 2006, Vario-scale Data Server in a Web Service Context. In Workshop of the ICA Commission on Map Generalisation and Multiple Representation, 25th June 2006, Vancouver, USA.