Evaluating location-based functionality from the perspective of the user: a case study from the Greenwich Observatory

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1. Introduction

The increased take-up and capacity of mobile networks (such as 3G networks) and *location-aware* wireless mobile devices has led to the development of a new class of applications, often referred to as location-based services (LBS). The use of LBS technology is growing rapidly, as users are able to exploit the services and context with the help of positioning technologies. The main emphasis of LBS technology is the ability of the mobile device to respond to the user's state, location and surrounding environment (Pagonis and Dixon 2004).

The paper reports research within the field of LBS in collaboration with the Royal Observatory at Greenwich. This comprised the implementation and evaluation of a prototype location-based service that acts as a "mobile guide" for visitors to the Observatory and its surroundings, providing contextual information via three alternative LBS interfaces . (Banerjee, Agarwal, Kamel, Kochut, Kommareddy, Nadeem, Thakkar, Trinh, B., Yossef, A., Youseff, M., Larsen, Shankar and Agrawala, 2002).

1.1 Aims

The project aimed to develop and design a fully functioning prototype LBS that will deliver relevant, spatially referenced information for visitors to the Greenwich Royal Observatory, and to assess alternative approaches to retrieving that information.

1.2 Objectives

The specific objectives are:

1. Conduct a user requirements assessment for visitors to the Royal Observatory;
2. Develop a prototype location-aware mobile guide based upon these requirements;
3. Carry out evaluation study of Observatory visitors to assess the suitability of different location-aware applications for different user groups, and to determine whether the specified user requirements have been met;

2. Research Context

Location-Based Services (LBS) are "*services that integrate a mobile device's position with other information so as to provide added value to a user*" (Schiller and Voisard, 2004 a). LBS functionality may be delivered through a range wireless devices including smart phones and laptop computers, however, personal digital assistants (PDAs) are one of the mobile handheld devices that promise to enrich our experience of the world around us. An advanced PDA can be used as a cell phone, media player, web browser and photo camera. Increasingly, these devices come shipped with an integrated GPS chipset, or the software to connect to a wireless GPS receiver. Despite the opportunities for LBS in this hardware environment, mass commercial take-up of these services has been poor. One reason proposed for the poor take-up of these services has been a lack of consideration by developers of usability and human computer interaction concerns.

Human Computer Interaction (HCI) is an interdisciplinary subject that educates the developer to deliver a desirable, efficient, and effective interactive application. (Dix, Finlay, Abowd and Beale, 1998 a). This includes obtaining and prioritizing the functional and non-functional requirements that stakeholders have for a system. The ACRE framework proposes methods for gathering a complete set of requirements from stakeholders by combining various acquisition techniques. (Maiden, 2005 a).

The design stage involves the decomposition of the components into smaller ones. Based on the detailed description the components are coded in some programming language. Finally, the coded components are implemented (Dix, Finlay,

Abowd and Beale, 1998 b). Following development, the system may be evaluated to determine whether the design meets the requirements of end-users. An effective and appropriate technique for evaluation of this kind is the questionnaire – a quantitative evaluation method that is relatively inexpensive and at the same time it can reach a wide group of users. In addition, a questionnaire can be analyzed more rigorously (Dix, Finlay, Abowd and Beale, 1998 c).

3. Establishing user requirements

There is a wide range of acquisition methods, ranging from ethnographic to constructivist available to requirements engineers. Software engineers face a problem, however, when choosing a method: there is no single guideline on how to choose or plan a well structured and efficient acquisition programme. Maiden and Rugg devised the ACRE framework to overcome this problem . (Maiden and Rugg, 1996).

The ACRE framework was employed within this project to ascertain user requirements. Two steps were undertaken in order to employ the framework. The first step involves determining acquisition needs. The second step entails selecting the acquisition method. Maiden and Rugg reviewed and presented 12 acquisition techniques in the ACRE framework (Maiden and Rugg, 1996):

Techniques	Description
Observation	The requirements engineer observes the stakeholders at the work place in or order to capture the essence of their job.
Structured interviews	The engineer interviews one or more stakeholders with prepared list of questions.
Unstructured interviews	The engineer interviews one or more stakeholders with an unprepared list of questions.
Brainstorming	The requirements engineer pools ideas from a group of stakeholders.
RAD workshops	Group of 8-20 people and the engineer interchange with the ideas of the future system design.
Protocol analysis	Someone performs a particular task and the same time speaks out loud during it.
Card sorting	The stakeholder receives a set of cards with some domain entity written on it. He or she sorts the cards into groups and after justifies his reason.
Rapid prototyping	The stakeholder presents the feedback on the design of the prototype model of the future application.
Scenario analysis	Scenario represents the sequence of actions that should be carried out in order to accomplish a particular task.
Ethnographic methods	The requirements engineer monitors the users at their work place for periods of time.

Figure 1. Review of Acquisition Techniques

Due to time constraints and the need to determine high-level requirements, two techniques for the Greenwich application were chosen: interview and brainstorming sessions were carried out with the assistance of the Exhibition Projects Manager at the National Maritime Museum. This individual was chosen as they are very familiar with the needs of the visitor to museums and facilities in the Greenwich area.

In addition, the Greenwich district was observed and its website was reviewed for a potential buildings, monuments and attractions. Finally, the requirements were analyzed and a subset selected that could be achieved within the time available for the project.

4. Application Design and Development

4.1 Application design

The user-requirements placed a great emphasis allowing retrieval of information not only on the basis of theme, but also location. For this reason, all content for this LBS

was linked to a feature on the ground. This geocoded spatial footprint was then stored in an xml file, with a link to the relevant item of content (e.g. html page).

The Greenwich guide could therefore locate the user's position as well as any feature of interest within Greenwich Park and city centre. In order to visually represent the relationship between the user location of that of relevant features of interest, on the map, the prototype used four maps over which these spatial features could be displayed. The selected maps were:

1. Ordnance survey (1:50,000) (figure 2)
2. Ordnance survey (1:25,000) (figure 3)
3. Greenwich visitor map (≈ 1:6,750) (figure 4)
4. Aerial photography (≈ 1:5,000) (figure 5)

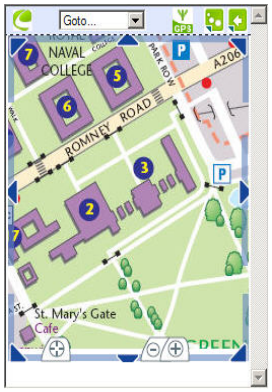


Figure 2. Visitor Map

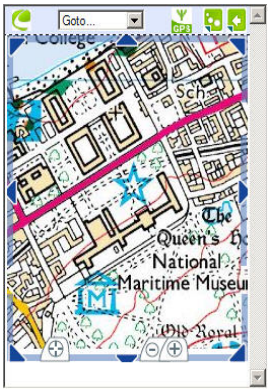


Figure 3. Ordnance Survey (1:25,000)

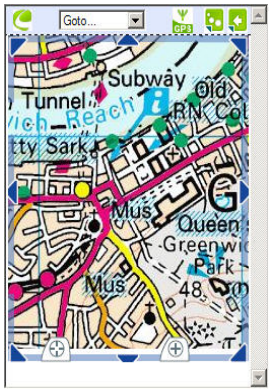


Figure 4. Ordnance Survey (1:50,000)

Figure 5. Aerial Photography

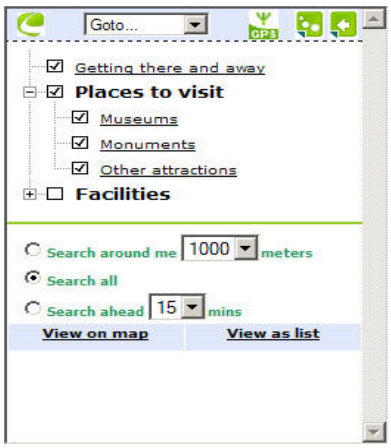
There was also an emphasis on the organisation of information by subject. A hierarchical framework was selected based broadly on user task. At the top level, subjects divided into "getting there and away", "places to visit" and "facilities" (see figure 7). These themes subdivided further, as described in the section 4.2.

Three applications were designed with the intention of satisfying different user requirements. The location-aware directory search allowed quite complex queries to be formulated based upon spatial criteria and theme (e.g. "museums within 1000m"). The "top 5" application aimed to provide an overview of the highlights and had no spatial criteria. Finally the "around me" search reported features that were close by, and did not filter information by theme. Each application is described in more detail below.

The front page to the prototype application, with links to the main applications in shown in figure 6.

Figure 6. Home Page

4.2 Location-aware directory search Application



The "Directory Search" application allows the visitor to search for a specific attraction or facility. There are three main categories of information: "Getting there and away", "Places to visit" and "Facilities". Spatial filters can be applied to restrict the query, for example, "within 1000m"

Figure 7. "Directory Search" Application

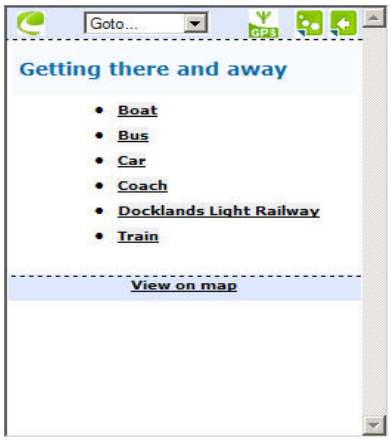


Figure 8. Transport Guidance

The first of the three categories presents "Getting there and away". This is used by visitors wishing to travel to and from Greenwich using one of six means of transport (figure 8). The web page link is available to provide information on the selected means of transport.

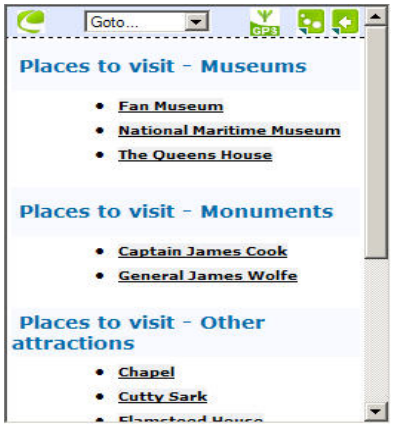


Figure 9. Places to Visit

The second category presents "Places to visit" including museums, monuments and other attractions. The web page link is available to provide information on the chosen attraction.

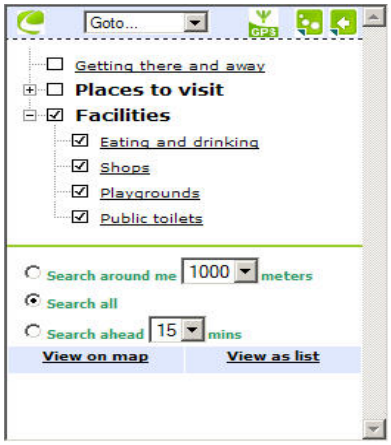


Figure 10. Facilities

The third category presents Facilities, which include restaurants, shops, playgrounds and public toilets. The web page link is available to provide information on the chosen facility.

4.3 The 'Top 5' Application

The "Top 5" application displays five most visited attractions at Greenwich. This application is intended to provide an overview of the main highlights, for visitors who have never been to Greenwich before.

Figure 11. "Top5 Application"

4.4 The 'Around me'

The "Around Me" application locates points of interest that are within the user's vicinity (500m radius).

5. Evaluation and Results

Twenty-five end-users participated the evaluation study. The analysis differentiated between participants on the basis of age and level of experience with PDAs. Our analysis shown that both functional and non-requirements were met. This is demonstrated by the following. The results suggest that PDA characteristics are suitable for Greenwich user guide application since the majority of the participants provided a positive feedback on PDA's characteristics.

Most of the users found that "top 5" application provided relevant information. Despite this, quite few participants point out that more places of interest should be included in "top 5" application. The younger generation of respondents would like to see shops whereas the older respondents would like to see restaurants.

The users' feedback regarding "around me" application is very positive. Additionally, the majority users agreed that "around me" application let them know what was in their local vicinity.

The results indicate that almost half the users found the "category search" application easy to employ. A majority of all respondents were able to formulate a

very specific query using “category search” application. Those (few) participants who had never used a PDA before did, however, find the application difficult to use.

The research suggested that the Visitor map is the most popular map style. Most of the older respondents, however, preferred the Ordnance Survey style, possibly because it is a more traditional way of presenting spatial information in Great Britain. The vast majority of participants thought that the Aerial Photography map was too zoomed in. As a result, it was the least popular style.

6. Acknowledgements

I would like to express my gratitude to the staff of the National Maritime Museum and Greenwich Observatory for assistance and advice, particularly. Alice Graham for helping to specify the user requirements for the prototype application. Thanks also to Stephen Yeo for guidance, advice on various drafts and constructive criticism.

7. Biography

Raikhan. Zhumagulova: Having finished my postgraduate MSc in Information Systems and Technology, I am currently working as an IT Assistant at the Centre for Economic Policy Research. The role includes VOIP integration, networking and website design.

8. References and Citations

Banerjee, S., Agarwal, S., Kamel, K., Kochut, A., Kommareddy, C., Nadeem, T., Thakkar, P., Trinh, B., Yossef, A., Youseff, M., Larsen, R. L., Shankar, U. A. and Agrawala, A. (2002) Rover: Scalable Location-Aware Computing, University of Maryland, College Park, IEEE Computer, 2002.

Dix, A., Finlay, Abowd G. and Beale R. (1998 a) Human-Computer Interaction, Bath: Prentice Hall Europe, pp.1-4.

Dix, A., Finlay, Abowd G. and Beale R. (1998 b) Human-Computer Interaction, Bath: Prentice Hall Europe, pp.181-183

Dix, A., Finlay, Abowd G. and Beale R. (1998 c) Human-Computer Interaction, Bath: Prentice Hall Europe, pp.432-435.

Longley, P. A., Goodchild, M. F., Maguire, D. J. and Rhind, D. W. (2001) Geographical Information Systems and Science, New York: John Wiley & Sons, Ltd, pp.122-125.

Maiden, N. A. M. (2005 a) Requirements Engineering, Lecture Notes in Requirements Engineering, 2, p.5.

Maiden, N. A. M. and Rugg G. (1996) ACRE: Selecting Methods For Requirements Acquisition, Software Engineering Journal, 11. Available: http://www.haumer.net/rational/files/SEJ96Paper.pdf [15 Nov 2006]

Pagonis, J. and Dixon, J. (2004) Location Awareness and Location Based Services – Part I Positioning and Terminology, Symbian Ltd, 2004.

Schiller, J. and Voisard, A. (2004 a) Location-Based Services, San Francisco: Morgan Kaufmann Publishers, p.10.