Chapter 37
User-Centered Design of Mobile Geo-Applications

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ABSTRACT

One purpose of this chapter is to inform about the geographic aspects that make mobile geo-applications different from other mobile software applications: (1) positioning techniques (like GPS) with which mobile devices may be localized in geographic space; (2) access to additional geographic attribute data; and (3) the representation of geographic information by means of maps on the display screen of the mobile device. Another objective of this chapter is to highlight the relevance of use and user (and not just usability) research in system and mobile software engineering and to describe the application of various research methods and techniques in a user-centered design approach. The characteristics of a mobile geo-application and the implementation of a user-centered design approach are illustrated by means of a research case study aiming at the development of more usable navigation systems for pedestrians.

INTRODUCTION

Since the moment that location tracking can be done with a reasonable degree of accuracy, the functioning of more and more mobile applications is based on, or related to, knowledge of the geographic location of the user with his or her device. This moment in time may very well be defined: it is the year 2000 in which GPS signals were no longer deliberately distorted for non-military users. Since then, we have witnessed a rapid growth in the implementation of personal navigation systems, particularly car navigation systems. The mobile software required for these systems may be installed on dedicated devices (in-car navigation systems), but became increasingly available on multi-purpose devices like PDA's and smartphones as well. The route directions to a user's destination, as provided by a navigation system, are commonly described as a *Location Based Service (LBS).* Nowadays, there are many more examples of mobile LBS-applications in

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various stages of (prototype) development (URL 1). You may think of Google Latitude (URL 2) or smaller applications with which you can keep track of where your friends or your children are. Other applications may guide you to the nearest restaurant or free parking space or help authorities to charge you for the toll roads you have used. A workforce management application can be used by companies to direct a service-man who is most nearby to an incident of equipment failure and you may also think of applications that provide the user with a personal, location based, weather forecast. With increasing positioning accuracy there are already examples of professional applications which, when coupled to an appropriate geographic dataset, may inform their users about the underworld infrastructure (location of underground cables and pipes).

The last example shows that it is not only the knowledge of geographic location that matters. This location is always linked to geographic information, often represented by means of a map display, which should also be available to the mobile device. So, we are talking about *mobile geo-applications* when the application is not only making use of the knowledge of the geographic location of the mobile device but is also providing access to geographic information so as to provide its users with the services requested.

This chapter has two main objectives:

- To inform the reader about the geographic components of *mobile geo-applications* and
- To highlight the relevance of *use and user research* in system design and implementation and describe the application of various research methods and techniques in a *user-centered design approach*.

These aspects will be illustrated through a description of a research case study aiming at the design of a prototype of a pedestrian navigation system.

MOBILE GEO-APPLICATIONS

In the framework of this chapter, three aspects of mobile geo-applications need to be discussed in somewhat more detail: *positioning*, *geographic data* and *mobile maps*. These are the three geographic aspects that make mobile geo-applications different from other mobile software applications.

Positioning

There are several techniques with which mobile devices may be localized in geographic space. Pourabdollah & Jackson (2009) have distinguished the following general positioning systems: dead reckoning (inertial systems with e.g. accelerometers, gyroscopes, magnetometers), reference-based (various wireless solutions, based on e.g. global navigation satellite systems, cellular mobile phone networks, WLAN/Wi-Fi, WPAN/Bluetooth, RFID, laser, ultrasound, Ultra Wide Band), relative (multi-user solutions) and integrated systems. A factor of great importance is whether a user with a mobile device is moving into an indoor or an outdoor environment. Of course, it also depends on with which types of devices we are dealing and what kind of sensors they contain.

Reference-based systems are most commonly used on mobile devices. The algorithms applied are often based on mathematical calculations with the known locations of at least 3 or 4 reference stations.

Cell phones transmit and receive signals to and from cell towers in a provider's network. Usually they are "in contact" at the same time with several of these nodes with known geographical locations and with these *cellular data* and the appropriate software the location of a cell phone may quite easily be determined. In this way, examples are known of telecom providers selling location data of mobile phones in cars for use in car navigation systems to determine travel speeds and localize traffic jams. However, providers do normally not make their cellular data freely available, if only