Designing for the Wild: There is More than Mobiles, Smartphones, PDAs and Tablet PCs

Mario Pichler
Software Competence Center Hagenberg (SCCH)
Hauptstrasse 99, A-4232 Hagenberg, Austria
mario.pichler@scch.at

ABSTRACT

Context-Awareness plays a major role for the success of mobile applications; this is true for context-aware (software) services as well as for the used devices themselves. Therefore, within this paper, we want to discuss the usage of context-specific mobile devices as target platforms for new mobile applications. Nowadays, the primary application platforms taken into considerations for new mobile applications are mobile phones, personal digital assistants (PDAs), and tablet PCs. Because of this, the specialties of the device itself—its characteristics, features, and constraints—are lost. This is also the case for the majority of known mobile guide systems. A selection of mobile devices, being possible platforms for future mobile applications and a number of case studies of those alternative devices as mobile guides will be given.

1. INTRODUCTION

A huge number of different mobile devices satisfying a broad range of requirements is available on the market. For this reason, part of the vision of pervasive computing, namely to migrate information and communication technology from the desktop into our everyday lifes, is already on the way. These devices should also be taken into account when designing new mobile applications. Nowadays, the primary application platforms taken into considerations for new mobile applications are mobile phones, personal digital assistants (PDAs), and tablet PCs.

However, people are using different devices for different activities, e.g. dive computers for diving, altimeters for mountaineering, heart rate monitors or running computers for running, cycling computers for cycling, combinations of cycling computers and altimeters for mountain biking, GPS devices for hiking etc. These specialties of the device itself—its characteristics, features, and constraints—are lost if only general purpose devices are considered as possible platforms for new applications.

As has been shown in a wealth of previous works, context-awareness is a major issue for the success of mobile applications. This is true for context-aware (software) services as well as for the used devices themselves. Therefore, within this paper, we want to discuss the usage of context-specific mobile devices as target platforms for new mobile applications.

The remainder of the paper is structured as follows: in Section 2, we clearly state the problem to be tackled in this paper. In Section 3, we underpin this problem statement by presenting the results of a literature study about mobile guide systems. Furthermore, examples of mobile devices as potential platforms for future mobile applications are given in this section. A case study of context-specific devices as mobile guides for mountain bikers is presented within Section 4. Two examples of cooperations among experts in different fields for device and service development are given in Section 5. In Section 6, we discuss our observations and, finally, conclude the paper in Section 7.

2. PROBLEM

Being participant of Mobile HCI 2003 conference in Udine, one could observe that there is a great demand on new (and innovative) mobile applications. Among the statements of the panelists in the panel discussion on 'Vision of the Future' were the following. "*Technologies are there. Now there is the question on finding the right applications for mobile devices.*" Another issues were "*methodologies for identification of future potential*", "*evaluating in real mobile contexts*", "*the necessity of more tools to rapidly evaluate user interfaces, because of time to market constraints*", and "*to find a balance between complexities of devices and ease of use*".

One of the panelists suggested "*moving away from concentrating on PDA-like devices towards standard mobile phones, because these are the devices that are used in the mass-market*". We think that such a limitation of the target hardware is one of the reasons why it is so difficult to find the right applications for mobile devices.

A huge number of different mobile devices satisfying a broad range of imaginable requirements is already out there. We cannot ignore them. They are used for specific activities and, therefore, they are designed for a specific context of use; they have specific characteristics, features, form factors, constraints, and, they also have drawbacks.

The usability of those devices often keeps people off using them. The mentioned issue of finding the balance between complexities of devices and ease of use is also encountered here. In many cases, users are simply asked too much when it comes to interact with their devices to use the offered functionality. A cycling computer is a good example. It offers a number of features, which are controlled via a very restricted number of buttons, which represent the input interface for the user. Having read the manual, users are able to use a subset of features, namely these ones which are interesting for them. Over the winter, when they do not use the device for a long time, people forget how to use the required functions. They have to read the manual again or to ask a person who is familiar with the device.

To address the remaining above-mentioned statements of the panelists, we suggest to evaluate the usability of devices already out there. Designers can learn from the results, and, also those devices are subjects for improvements and, therefore, represent potential platforms for future mobile applications.

3. MOBILE DEVICES AS APPLICATION PLATFORMS

A survey of mobile guides [6] has been presented at the 'Workshop on HCI in Mobile Guides' in 2003. Having a look on the systems compared in this survey as well as the other published papers in this workshop series, we identified the following devices as major target platforms for mobile guide systems: mobile phone, PDA, tablet PC, car, laptop, kiosk, wearable computer, notice board, and television monitor.

In [3], a mobile device landscape is given that also includes multi-function watches and game devices; they are increasingly becoming valuable parts of our lifes. However, no mobile guide systems utilizing these devices are mentioned.

In [12], the authors mention that "*it is extremely important that the device is designed for the needs originated in a specific work situation and suited to the environment in which it will be used*".

The remainder of this section gives examples of further mobile devices in order to motivate the thinking that there is a number of devices out there which represent potential platforms for future mobile applications, even as for mobile guides. Those devices are designed for specific purposes and, thus, offer specific services to their users. Some ones are used for control or information purposes only; the usage of other ones is indispensable to life in some situations.

Heart Rate Monitors and Running Computers

A heart rate monitor supports a runner to adapt her/his running speed according to her/his physical fitness. If she/he runs too fast or too slow, the device informs the user about the deviation from the planned heart rate range. The heart rate monitor acts as guide for the runner. However, it is not a necessity for a runner to use a heart rate monitor in normal circumstances. From this point of view, it can be understood as provider of some useful information for the user.

Dive Computers

A dive computer offers similar functionality to the diver—it guides the diver. But compared to a heart rate monitor, its usage is vital for the diver as she/he has to adhere to an adequate ascent rate. Therefore, a dive computer instructs the diver to slow her/his ascent rate if the maximum ascent rate is exceeded. With deep dives, another vital function is the calculation of safety stops for decompression. In this case, the dive computer instructs the diver to remain in a specific depth-range for a specific time period. Maximum depth and dive time alarms are other important features of dive computers. Assuming that divers pay attention to their surroundings, adequate mechanisms for informing the diver, like activating the backlight of the computer and/or audible sounds, are crucial. Ignoring or simply not recognizing these alarms can be life-threatening for the diver.

Avalanche Transceivers

Other devices that can save lifes are avalanche transceivers. They are used by mountaineers in snowy terrains. The goal of an avalanche transceiver is to aid the search of a person buried by an avalanche. Therefore, an avalanche transceiver primarily offers two functions. Firstly, it transmits signals for location detection of the transceiver and, secondly, it supports users in the process of searching buried persons. In the latter case, the device is used in search mode, in which it receives the transmitted signals of other devices and than guides the searcher to the buried person.

Altimeters and Navigation Devices

We have already mentioned mountaineering as application domain for mobile guide technology. Further devices are used in this domain, like altimeters for climbing or GPS (Global Positioning System) devices for navigation support on hiking tours. These devices provide added value especially in emergency situations. A possible emergency situation in the mountains is the abrupt appearance of dense fog. Each single footstep can be dangerous in such a situation. Up-to-date weather information and especially information about changes of local weather conditions represent invaluable information for mountaineers.

Summary

The usage of some of the introduced devices is indispensable to life in some situations, as the examples of dive computers and avalanche transceivers have shown. This fact alone states the importance of the human-device interface. A clear dissemination of information through the device and according actions of the user are of critical importance for all involved parties. Current available avalanche transceivers for instance require a lot of training—at least for non-frequent users—for a successful use in an emergency situation. For this reason, improvements of the human-device interaction would surely be honored as added value by the users. Some research is already done in this area [7].

In general, this section has shown that there are not only mobile phones and PDAs out there as potential platforms for future mobile applications. We argue that telecom operators, software companies, and others should take this into account when they are searching for new application fields. Improvement of the usability of those devices should also be subject of ongoing research.

4. CASE STUDY: MOBILE GUIDES FOR MOUNTAIN BIKERS

In this section we want to demonstrate the usage of context-specific devices as mobile guide systems for mountain bikers (MTB). We will compare GPS-based solutions as well as systems using other mechanisms for navigation.

4.1 The Mountain Bike Domain

Increasingly, mountain bike routes are marked with signposts. A famous example is the 'Alpentour Steiermark' [1], the longest end-to-end marked mountain bike route in the world (according to the website) in Styria, Austria. Signposts are placed on crossings and other crucial places and, therefore, normally allow the bikers to find the right way without using additional navigation aids. Examples of the used signposts are given in Figure 1. The route is marked in both directions, thus, bikers can choose the preferred direction.

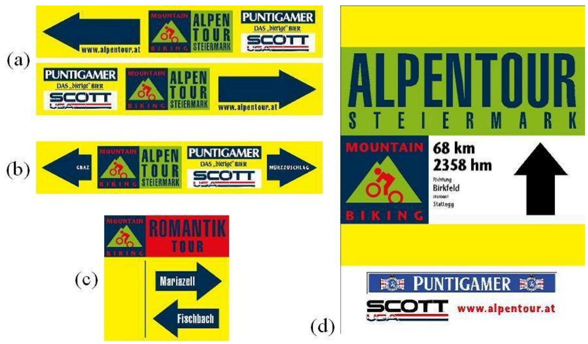

Figure 1: 'Alpentour Steiermark' signposts. (a) single signs for left and right, (b,c) signs for both directions, (d) main sign showing distance and altimeters to go, Source: [1]

4.1.1 *The Case for Navigation Support*

The above-mentioned 'Alpentour Steiermark' is marked quite well. Other routes are marked in one direction only. In this case, it is not intended that the bikers can choose the preferred direction. In other cases, the signposts are difficult to see as they are overgrown by trees or bushes for instance. At last, a huge number of mountain bike routes is described in paper guides with detachable maps of the tour or on personal web pages of mountain bikers, only. This situation has led to the need of other navigation aids. Also, even if a route is marked through signposts, the placement of these signposts is conceived for 'normal' tour speed. Thus, if the biker drives faster, it might be possible to miss a signpost and to get lost off the route.

In the following we will introduce and analyze mobile tour guides for mountain bikers.

4.2 GPS Devices as MTB Guides

In some tourism regions it is already possible to rent GPS devices with MTB routes stored on it. An example is the bike arena in South Tyrol [8]. Another one is GPS-Tour.info, a portal that offers free GPS routes for outdoor activities like mountain biking, hiking, riding or skiing [5]. From GPS-Tour.info, any interested person is allowed to download GPS routes to her/his computer and, via an also freely available software program, these routes can be uploaded to the personal GPS device.

For mountain biking, the GPS device is mounted on the handle bar of the bike and allows the biker to check the right way while driving and without any interaction.

Figure 2: GPS device mounted on handle bar, Source: [8]

In principle there are two possibilities to store a route on a GPS device. The first one is to activate and carry along the GPS device while driving the route. The device then automatically captures the route, which can be given a unique name and stored on the device for later reuse. The second possibility is to use a map application on a computer to create a route and send it to the GPS device.

Using a GPS device, it is possible to detect the owner's position with an accuracy of some meters. The GPS device (receiver) uses signals from satellites to pinpoint its exact location on earth. The number of satellites within line of sight to the receiver affects the accuracy of the position determination. Driving within steep valleys or ravines, in tangly woods or near rocks can affect the reception and further the accuracy of the GPS signal. First attempts using a GPS device for hiking in the woods and for ski-touring in the mountains confirm this drawback. For example we experienced an accuracy of 37 m while walking in a narrow pass in the woods. Walking back the same way and assuming the same accuracy may result in a deviation of about 70 m, which can be too much if two or more crossings are in close proximity.

These arguments are the motivation for manufacturers of other navigation devices without using GPS. We will introduce two of them in the following.

4.3 naviiON Bicycle Computer and Navigation System

The naviiON bicycle computer and navigation system by naviiON.com [9] is designed to provide navigational aid for bikers (Figure 3). Additionally, it supports the logging of routes through a number of sensors and through a voice recorder that can be used to create voice annotations while driving a route. These annotations can later be used to refine a tour description via naviiSOFT on a computer. Therefore, it also acts as a mobile guide providing exact information about specific locations. The user interface consists of a display showing relevant information, four buttons, two for navigating through the menu, one primarily to select the provided functions (the Enter key), and one for switching between different types of screens and the function of Escape; a microphone and a speaker are integrated for the voice recorder function.

Figure 3: naviiON on handle bar, Source: [9]

4.3.1 Creating Routes and Navigation

As already mentioned, naviiON does not use GPS for route creation and navigation. Instead, a three-dimensional point-to-point navigation mechanism is employed. These three parameters are the position (or distance) between junctions, the altitude profile of the route, and the current direction.

Creating Routes

First of all, naviiON relies on the information the user enters into the system. As a first step the user has to enter the circumference of the wheel for automatic measurement of the driven distance. While driving altitude, speed, temperature, distance, and time are logged automatically by naviiON. At each important junction the user has to enter the form of the junction and optionally additional information describing the situation. This is necessary for following the route later on. An example description of a junction consisting of three exits with the right one at the right side is given in Figure 4.

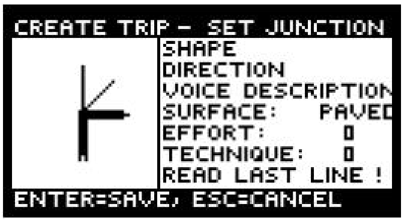

Figure 4: Created junction description, Source: naviiON user manual

This (manual) process of logging junction information might become cumbersome as it requires the biker to stop on each junction to enter the data. Therefore, a voice recorder is integrated that allows the biker to enter junction information via voice without stopping the ride. With the naviiSOFT software voice recordings can later be converted into text. The junction in the Figure 4 could for instance be described as 'Junction twelve, one, three. Direction three.' Additional refinements of the tour can include photos that were taking during the tour, which can be attached to way points (Figure 5).

Navigation and Guiding Others

The created tour descriptions can be uploaded to a Web portal, from where other users can download the routes to

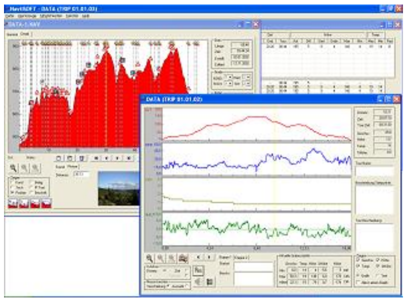

Figure 5: Log of tour in naviiSOFT, Source: [9]

their computers. Through a CompactFlash memory card, the downloaded routes are copied into naviiON. In this way naviiON users are not only able to download routes for own usage, but can also upload personally created routes for being used by others—users act indirectly as guides for other users.

For following a route, the user activates a route on naviiON. The user starts driving from a known way point. If deviations from the stored route are detected (e.g. because driving uphill while the route description foresees to drive downhill), the biker is alerted.

4.4 CICLO*Navic* Bicycle Computer

With CICLO*NAVIC*, a similar gadget is available from CICLOSPORT [2] (Figure 6). Descriptions of driven routes are created using the NavicEdit software on a PC. A voice recorder for creating annotations during a tour is not included. The process of sharing tours with other bikers is done through a Web portal, similar to naviiON.

Figure 6: CICLO*NAVIC* bike computer, Source: [2]

5. COOPERATIONS FOR FUTURE DEVICES AND SERVICES

Recent device development requires expertise from various fields. For this reason, cooperation among device manufacturers, telecom operators, and software companies seems to be fruitful. Two examples are the cooperations Suunto-Microsoft and Polar-Nokia, which will be introduced in the following.

Cooperation Suunto and Microsoft

Suunto [14] is one of the leading manufacturers of sports instruments for a variety of sports, including skiing, hiking, diving, sailing, and golf. Their strategy is to focus on sports activities where advanced measurement technology, data processing, and specific algorithms can create significant benefits for active participants.

(a) (b) (c)

Figure 7: Suunto n3 wristop computer with Microsoft's MSN® Direct Service. (a) up-to-date weather information, (b) received message, (c) Microsoft® Outlook® appointment, Source: [14]

As opposed to the other introduced devices so far, the Suunto n3 wristop computer is able to receive information like messages from family members through MSN Messenger and up-to-date information on weather changes, news, sports etc. through MSN® Direct service, which is available in the 100 biggest metropolitan areas in North America. It also displays appointments and personal datebook entries through Microsoft® Outlook®.

Cooperation Polar and Nokia

In February 2004, Nokia and Polar, manufacturer of sports instruments and heart rate monitoring equipment, announced a formal cooperation to bring the benefits of mobility to athletes and sports enthusiasts [11]. As a result of their cooperation the Nokia 5140 phone connects wirelessly with Polar products like the Polar S625X Running Computer and S725 Cycling Monitor. With this combination of devices it is possible to transmit workout data from the running or cycling computer via infrared to the mobile phone. Then, the phone can be used for analyzing and sharing this data with coaches or other persons instantly (Figure 8).

(a) (c)

(b)

Figure 8: (a) captured training data on Polar S625X, (b) transfer via infrared, (c) data ready on Nokia 5140 for analysis or to send to another phone, to PC software, or web service, Source: [11]

It can be observed that devices, originally not designed to send or receive data to/from the outside, are becoming able to communicate with their surroundings, as the given examples indicate. To reach this, cooperations among experts in various fields are necessary and can be a key for future success.

6. DISCUSSION

In this section, we want to discuss our observations based on the information of the previous sections.

Communication Among Mobile Devices

A subject for further improvements is the fact that most of the mentioned devices are not able to communicate with each other. If devices were able to do so, a lot of interesting applications would be possible, e.g. a spontaneous exchange of route descriptions among bikers or the exchange of other information (e.g. event information, bids for products etc.). Simplifications in emergency situations would also be possible if the devices were able to interact with each other. Users of avalanche transceivers could be better assisted in the process of searching for a buried person if interactions among the transceivers would be possible (see also [7]).

Communities

Another interesting fact is the growing importance of community applications. As has been shown in the case studies, users of bicycle navigation systems like it to share their routes and other information with like minded people. This is also true for the users of introduced sports devices in Section 3. Therefore, community applications that support the sharing of experiences are increasingly gaining in importance. This theme has also been discussed at the 'Memory and Sharing of Experiences' workshop at Pervasive 2004 in Vienna.

Support of Mobile Ad-hoc Communities

The support of mobile ad-hoc communities remains an open issue. Members of a bicycle community are able to download route descriptions or to read other information about like minded people when they are sitting in front of their laptop. However, when they are driving with their bikes, it is difficult for them to identify other members of the community or even to recognize that other members of the community are in the proximity (see [4] for a solution supporting motor bikers). Users of mobile devices could be supported with the identification of other community members, if the devices were able to communicate with each other, as already mentioned. If the device would also be able to detect the context of the user and share this context information with the devices of other users, matching contexts could be detected. This could mean that other bikers, runners, hikers, or skaters in the proximity could be detected by the device and the user could be alerted about their presence. Also, further applications could be triggered by detection of matching user contexts.

Usability of Devices

As already mentioned in Section 2 we see a great potential for improvements of the human-device interaction of the introduced devices. This is also true for mobile phones which offer a great burden, especially for older users, from the interaction point of view. It is also true for chronographs, heart rate monitors, cycling computers, digital cameras etc. People are interacting with technology through the user interface. We think that improving user interfaces for being usable by the broad mass of people would be recognized as a next step in technology development.

We have planned to do usability evaluations of the bicycle navigation systems introduced in Section 4.

General Purpose vs. Context-Specific Devices

Although, as we stated the importance of context-specific devices for the usage in specific situations, it will be problematic if a number of those devices have to be used together. With an alpine tour it is not always feasible to take along an avalanche transceiver, an altimeter, a mobile phone, a digital camera, and a GPS device for instance. We think that it depends on the situation which devices to choose. Norman is a proponent of 'information appliances' (simple devices for specific purposes) [10], while Starner proposes using a general purpose device (a wearable computer) [13] and tailor its behavior through software programs.

Cooperation

Cooperation among device manufacturers, telecom operators, software companies, and others seems to be a solid basis for future applications, as knowledge from different domains is necessary to satisfy future needs. Examples for such cooperations were given in the paper.

7. CONCLUSION AND FURTHER WORK

We have argued that not only the context-awareness of the software services plays a major role for the success of mobile applications, but also the specialties of the device itself. Therefore, we have discussed the usage of context-specific mobile devices as target platforms for mobile guide systems. While nowadays primarily mobile phones, smartphones, PDAs, and tablet PCs are considered as potential platforms for new applications, there is also a wealth of further devices out there that remain interesting for future developments. We presented a snapshot and case studies of those devices with an emphasis on devices supporting outdoor activities. Interesting issues and remaining questions have been discussed. Some of them build the basis for our further work, which will comprise two major activities.

At first, a detailed evaluation of existing bike navigation systems is planned. We want to evaluate two categories of systems: 1) devices like the naviiON navigation system and CICLONavic bicycle computer, which work without GPS and 2) GPS-based solutions. Results of the comparison are presented at the Workshop.

The second, and longer-term, activity comprises investigations on detecting context proximity of several people. These investigations will include further studies on available mobile devices in various domains and studies on sensors embedded in these devices. Furthermore, we will investigate if and how the sensor information provided by those devices can be used for detecting the context of the device user and detecting matching contexts of several people. The detection of matching or even similar contexts of mobile people will be the basis for mobile communities. Details about this idea will be published in another paper.

Acknowledgements

The author gratefully acknowledges support by the Austrian Government, the State of Upper Austria, and the Johannes Kepler University Linz in the framework of the K*plus* Competence Center Program.

8. REFERENCES

[1] Alpentour-Steiermark. Beschilderung. http://www.alpentour.at/facts/beschilderung.htm, 2004. Last visited: June 2004.

[2] CICLOSPORT. Ciclonavic electronic roadbook. http://www.ciclosport.de/, 2004. Last visited: June 2004.

[3] A. J. Cowell, T. E. Tanasse, and K. M. Stanney. Using anthropomorphic embodied conversational agents in mobile guides and information appliances. In *Proceedings of Workshop HCI in Mobile Guides*, Udine, Italy, September 2003.

[4] M. Esbjörnsson, O. Juhlin, and M. Östergren. The hocman prototype — fast motor bikers and ad hoc networking. In *Proc. of MUM 2002*, Oulu, Finland, December 2002.

[5] GPS-Tour.info. http://www.gps-tour.info/, 2004. Last visited: June 2004.

[6] C. Kray and J. Baus. A survey of mobile guides. In *Proceedings of Workshop HCI in Mobile Guides*, Udine, Italy, September 2003.

[7] F. Michahelles, P. Matter, A. Schmidt, and B. Schiele. Applying wearable sensors to avalanche rescue: First experiences with a novel avalanche beacon. *Computers & Graphics*, 27(6), 2003.

[8] mountainbiker.it. Suedtirol. http://www.mountainbiker.it/, 2004. Last visited: June 2004.

[9] NaviiON. Naviion bicycle computer and navigation system. http://www.naviion.com/, 2004. Last visited: June 2004.

[10] D. A. Norman. *The Invisible Computer*. MIT Press, Cambridge, MA, 1998.

[11] Polar. Mobile connectivity. http://www.polar.fi/mobileconnectivity/, 2004. Last visited: June 2004.

[12] I. Scandurra, M. Hägglund, N. Johansson, B. Sandblad, and S. Koch. User needs for development of context dependent devices in mobile home care. In *Proc. of Mobile HCI 2003*, pages 446–450, Udine, Italy, 2003. Springer-Verlag, Berlin.

[13] T. E. Starner. *Wearable Computing and Context-Awareness*. PhD thesis, MIT Media Laboratory, Cambridge, MA, 1999.

[14] Suunto. Sports instruments. http://www.suunto.com/, 2004. Last visited: June 2004.