Mobile Navigation Support for Pedestrians: Can It Work and Does It Pay Off?

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PEOPLE WHO ARE ON THE MOVE need to complete navigational tasks. They have to go from A to B as fast, efficiently, and safely as possible. Often navigation is not their main activity; they have something else to complete between the two points (particularly in stressful situations). They have to write an article for their boss, buy toys for their kids, go to the next book stall. The majority of these people are using mobile telephones, and researchers and the marketing departments of mobile service providers assume that these moving people could be happier, that they could have a better user experience, if they used their mobiles to get information about where to go next. In fact, there are already a number of devices and services on the market that support navigational tasks for drivers. While they do not sell like hotcakes, they do quite well on the market.

Is it possible to also sell such products to pedestrians? Or to put it differently: Would people like hikers or those who are navigating inside cities or complex indoor environments such as railway stations and airports benefit from similar devices and services? From our point of view the answer is "yes," but only if the following three prerequisites are fulfilled:

- consideration and integration of landmarks as a means of navigation
- more and real consideration of the context of use
- provision of content that goes beyond navigational information.

In the following we discuss each of these in more detail.

Figure 1: How would this shop be described so that it is a clear landmark to all users?

LANDMARKS, THE CORNERSTONE OF NAVIGATION. Pedestrian paths are not as clearly defined as roads. Consider environments like airports where there are not any paths, but rather huge areas with different spots and with many different exits. Therefore, descriptions relying on instructions such as "in 50 meters, turn right" are useless. Studies such as [4] and [5] investigated the characteristics of the information needed by pedestrians and found that landmarks formed by far the most popular and effective type of cue. The system does not ask you to turn right in 50 meters but does say, "At the blue sign of the bookstore, turn right."

Leading users by landmarks, however, means that landmarks have to be defined and updated thoroughly. Sefelin et al. [6] identified landmarks for a speech-based guidance system in a railway station, which led users from landmark to landmark to his/her final destination. The application of a combination of different methods (photo-based object recognition, video-supported thinking-aloud protocols, object detection and description) resulted in a very good appointment of possible landmarks.

Nevertheless, the authors showed that although most of the subjects mentioned almost the same objects, the names given to the objects differed strongly. Only bigger chains (e.g., Starbucks) seem to have a name that was agreed upon. In order to make sure that the system uses terms that are understood by all user groups, a further method had to be applied. The authors selected those objects whose naming differed significantly among the subjects of the three previous methods and used these for picture-based telephone interviews.

In some cases a description of the sign mounted above a shop is more useful than read-

ing a shop's name or trying to describe it according to the products that one can buy there. So a description like "Snack bar with the illuminated green sign" was clearer to the subjects than the description "Wettpunkt," which was the text written on the sign (see Figure 1). The authors drew the conclusion from this study that a combination of shop type and a description of its sign leads to the best results.

Although Sefelin et al. point out that, from a methodological point of view, the set of methods was easy and cheap to set up and hardly intrusive, still a considerable amount of human resources was necessary to define those landmarks. Although it may be possible that one day landmarks could be defined automatically, until now neither our knowledge on the generic characteristics of a landmark nor the technology (cameras and sophisticated algorithms) that could detect them seem to be sufficient.

Detecting landmarks requires advanced vision systems that can analyse and "understand" images and video sequences. State-of-the-art machine vision systems (e.g., developed within the Austrian research network; "Cognitive Vision": http://fsp.acin.tuwien.ac.at) are already able to identify different objects and to recognize categories of objects. Until now these methods had not been applied for the identification of landmarks. However, in the long run these technologies could play an important role when it comes to the automation of landmark definition.

CONTEXT OF USE. Whereas drivers of cars are mostly occupied with only one task, pedestrians usually have to complete different secondary tasks. Often the navigation is a secondary task, while the user's primary task is the exploration of a city or of a museum. Moreover, we cannot always expect that users in complex environments (railway stations, airports, hospitals) will be able to use a mobile phone or PDA with their hands. They might be carrying luggage, which would prevent them from using a mobile phone without a hands-free set; they might not want to attract the attention of other people; or they might need their hands to use a device such as crutches.

That means in certain application areas, the user group will be restricted to persons owning a hands-free set or comparable product and to those who are willing to use it in a certain environment. From previous studies with tourists we know that a vast majority of users refuse to use headphones [2]. It may be that wearable computers could solve these issues in the far future.

Van Erp et al. developed and tested such a system [7]. The system calculated the direction and distance of the waypoints and translated them into a tactile picture. This picture was displayed using eight tactors, placed at adjustable distances on an elastic band worn around the waist over the participant's own t-shirt. The elastic band was adjustable to enable a tight but comfortable fit. The location of the eight tactors was adjusted to the participant's body size so that they covered the cardinal and oblique directions. The tactile waist belt proved to be an effective navigation display. After approximately 30 minutes (five routes), the participants demonstrated acceptable effective walking speeds (4.2 to 4.4 km/h).

Maybe Van Erp. et. al. tested the navigation system of the future. Maybe each belt in the future will be connected to such a system. However, we assume this is rather unlikely in the next few years. Finally, we must consider that the subjects who participated in the tests were between 18 and 24 years old. We do not know how this system would support elderly users whose tactile sensitivity is much lower. Much further field work seems to be needed before such a system could be used in real life.

Another aspect related to the users' context is the fact that tourists and hikers often want to carry paper-based guides in their hands, which precludes the use of electronic devices. This point brings us to the last prerequisite that we would like to discuss.

PROVISION OF ADDITIONAL CONTENT. Interviews and focus groups with visitors of railway stations and hikers showed very interesting results (they were conducted as part of

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the projects WalkOnWeb, www.walkonweb.org, and Zielleitung, http://zielleitung.pvl.at). Both groups agreed that electronic devices would be perceived as useful only if they showed further information and supported more than navigational tasks. Visitors of railway stations, for example, need information on the timeliness of the trains and on the platforms from which their connections will leave. For them the provision of this additional information is an important reason for or against using a mobile device.

Hikers have very clear ideas on further features that a guidance system should provide. The following list summarizes some of the "wishes" that came up during interviews and focus groups with different hiking user groups:

- Information on shortcuts and alternative routes: Hikers with children often have to abandon their hikes and find the next means of public transport.
- Information on the length of a hike: Hikers want to be informed on the total distance in hours and km. and on the remaining distance in hours and km. The estimation of the remaining time should be in accordance with the current hiking speed.
- Information related to the hiking path's history and to its biological characteristics (very important)
- Accessibility of the route, particularly seasonal information suitable for families (pushchairs)
- List of the equipment that is needed on a particular hike (especially important for adventure hikers).

Designers can develop services for mobile devices that help users to explore their environment in a creative way. A certain group of tourists appreciates using the device-camera to recognize features [3], but the device does not provide any added value that could not be achieved with another technological solution such as GPS.

Baillie et al., however, show a model in which the mobile's screen acted as a "window to the past" [1]. Looking, for instance, toward a sight and aiming the mobile device in the same direction allows the user to sweep back in time to experience how this building has changed during the past decades. The device acts like a pseudo see-through device and shows the user exactly what he/she would have seen 50 or 100 years ago. Although this service is still not more than a prototype, it shows how the future tourist guides could behave. Navigation will be one of their functions but it must not be the only one.

CONCLUSIONS. Electronic guidance systems can be successful and useful. There are prerequisites for the success of these systems. Empirical evidence suggests that, on the one hand, guidance of pedestrians must be based on landmarks and, on the other hand, the definition of landmarks requires a relatively high amount of resources. The potential user groups for different guiding systems are limited because the usage of such services often requires further electronic equipment. Unobtrusive systems based on tactile feedback are still under development. There is a need for the enrichment of pure navigation; users want to see a clear added value before they leave their paper-based equivalents.

We do not argue that guiding systems for pedestrians will not work and will not sell. There are different systems on the market that are serving certain user groups very well. However, a system from which the majority of travellers, hikers, tourists, etc. can benefit still seems far away.

This conflicts with the success of navigation system for drivers. But, whereas these systems are rather easy and relatively cheap to develop, the production of systems for pedestrians is very challenging and costly. That is why the development of mobile applications is so tricky: If you change parts of the context, the whole service and its user requirements change completely.

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