

Learning From Insects? Towards Supporting Reflective Exploration of Unfamiliar Areas of Interest

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ABSTRACT

First experiences with a mobile information system aimed at supporting reflective exploration suggest that the device's visualization of past activities and, in particular, the routes taken helps participants orientate themselves and plan the next steps of their explorative activity. Drawing from insect navigation research we provide a preliminary explanation of some intriguing behavioral observations made during deploying mExplore as a technology probe. We also speculate about using mobile information systems to help visitors conduct "learning flights" and thus help them better understand the environment they are exploring by helping them recognize the varying visual impressions of landmarks from different perspectives. This work thus links in a unique way work on mobile information systems in tourism and other information-oriented areas to insect navigation research and (human-oriented) research into landmark salience and its use in ego-centric navigation.

Author Keywords

Design, Usability, Usefulness, Experimentation, Human Factors, Navigation.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Understanding and supporting leisure activities has become a focus of computing researchers interested in the context of using technology. Examples include tourists visiting museums (e.g., Fleck et al. 2002; Cabrera et al. 2005) and tourists exploring unknown terrain (e.g., Cheverst et al.

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2000; Brown and Chalmers 2003). Increasingly, museums maintain technically advanced web sites allowing prospective visitors to conduct "pre-visits" (Panel Museum Informatics at ASIS&T, Charlotte NC USA, Nov 2005)

A major theme in this research area is providing visitors and/or tourists with additional information about the environment they are exploring. Finding out about the kind of information users would appreciate *in situ* has shown to be difficult as "exploring" has shown to be best described as a deeply situated activity influenced by ever changing interests, priorities and environmental conditions. Aspects influencing user behavior range from weather conditions opening times to more personal aspects. By conducting field tests involving real tourists, Cheverst et al. (2000) discovered that approaching attractions, such as landmark buildings, can be desirable even if they are closed at the time. Fleck et al. (2002) observed during field studies in a museum that contrary to initial expectations, museum visitors were not necessarily interested in additional information about artifacts on display.

Recent advances in navigation technology (in particular GPS and WiFi but also RFID based solutions) enabled most mobile information devices to determine and thus track their own location. Such information can be used, for example, to provide visitors information about the behavior of previous and/or concurrent visitors including friends and strangers (e.g., Davies et al. 2002; Laurillau and Paterno 2004; Olofsson et al. 2005).

Providing visitors information about their *own* past behavior hasn't received much attention in the literature though. Many systems (e.g. Fleck et al. 2002) touch upon related issues but such systems tend to aim at providing resources for remembering (e.g., "My MoMA Visit") not for what we would call reflective *in situ* exploration.

In this paper, we describe first experiences with a mobile information device aimed at supporting reflective exploration of unfamiliar areas of interest. In addition to depicting information about the area the user is exploring, the device provides information about the user's own

ongoing as well as immediate past activities. In this paper we focus on the device's visualization of past activities and, in particular, the routes taken by participants.

We proceed as follows. First, we describe some of the assumptions guiding our research into the usefulness and usability of mobile information systems in the context of mobile leisure activities. Then we provide a preliminary analysis of some of the data we collected during field experiments conducted in an historic area of interest to tourists. Drawing from insect navigation research we interpret some unexpected findings. The paper closes with an outlook on future research in this area.

EXPLORING USABILITY AND USEFULNESS OF MOBILE DEVICES IN THE CONTEXT OF LEISURE ACTIVITIES

Our research is aimed at understanding how tourists explore unfamiliar areas of interest which means we are looking at leisure activities. Defining leisure is not as straightforward as it seems (e.g., Howe and Rancourt 1990). Passmore and French (2001), for example, suggest that freedom of choice and enjoyability are crucial to an activity to be considered leisure.

Researchers interested in using ICT to support and/or enable specific activities ranging from work processes to leisure activities may choose from a range of very different approaches. Considerable effort is being spent on trying to understand what tourists actually do while exploring an area of interest, and if (and how) activities observed could be supported by mobile technology. Often this research involves using ethnomethodologically inspired methods when describing respective practices (e.g., Brown and Chalmers 2003). A complementary approach, often found in more engineering-oriented research communities, is to explore what is technically feasible first and then to see how this could fit into what tourists would use. Often, the value of such technologies and their relevance to practice is unclear as respective practices do not yet exist (Crabtree 2004). Kjeldskov and Graham (2003) however argue that the bias towards building systems and a lack of research for understanding design and use actually limits the development of cumulative knowledge on mobile human computer interaction which in turn inhibits development of the research field as whole.

For our own research we decided using a mobile information system as a technology probe would help us uncover and hopefully understand certain details of how tourists explore unfamiliar areas of interest. A technology probe is "a particular type of probe that combine the social science goal of collecting information about the use and the users of technology in a real-world setting, the engineering goal of field-testing the technology, and the design goal of inspiring users and designers to think of new kinds of technologies to support their needs and desires" (Hutchinson et al. 2005). The probe we used was built upon an existing mobile learning system [reference removed for reviewing] that had been modified to meet our

requirements. The system will be described in more detail in the next section.

mEXPLORE: AN INFORMATION SYSTEM SUPPORTING REFLECTIVE EXPLORATION OF AREAS OF INTEREST

As mentioned before we are interested in ways to support what we call reflective exploration of areas of interest. By this we mean the provision of computational or other resources that help visitors not just choose and locate attractions but also help them reflect upon what they have experienced as yet.

To the contrary, most mobile information systems in the tourism area support what we might call object-driven exploration: guiding the tourist through the area by visualizing his or her current position plus the location of nearby attractions and associated information, such as opening times (e.g. Cheverst et al 2000). Often such systems offer to act as "guides" in the sense that they depict routes to attractions listed by the system's developer as being of interest to tourists or chosen by the tourist. We use the term guide to denote "a system closely related to the user's physical location and objects in the user's immediate surroundings" (Kjeldskov et al. 2004).

A typical scenario illustrating reflective exploration (deliberately kept simple as it is merely for illustration purposes) would be a tourist exploring an area of interest, pausing for a moment to consider what he or she has explored during the past couple of hours and to determine what he or she would like to do next. One option might be to continue the activity in an adjacent area. A second scenario would be a visitor returning after a few months to the Desert Park in Alice Springs having the intention to explore those parts of the park that he or she missed during the previous visit. In both cases, a reflective information system could provide information resources that come handy when the visitor determines what he or she has seen already (or during the last visit) and what areas are yet to be explored.

This underlying vague and somewhat "situated" view on exploration is inspired by our own extensive travel experiences but is also backed by the literature including ethnographic studies of tourists exploring cities. Brown and Chalmers (2003) suggest that "destination" may not always refer to a specific location but can also mean loosely specified areas.

This means we are less interested in devices that help construct the most efficient route as route recommendations to be found in standard guide-books serve this purpose fairly well. Of course guide books can also be used as a resource for reflection while browsing an area but then the guide book is used more like a resource providing information about objects of interest (buildings, places, etc) than as a book that "guides" as it is the tourist who organizes the specific details of how he or she explores the respective area.

There is an ongoing discussion as to whether it is necessary or at least advisable to conduct usability and usefulness tests in authentic environments rather than in simulated environments. Regarding usability evaluations, Kjeldskov et al. (2004) argue that the added value of conducting usability evaluations in the field is very little and that recreating central aspects of the use context in a laboratory setting enables the identification of the same usability problem list. This is certainly true when focusing on core usability issues but the kind of data we are interested in would be difficult to obtain if we as designers/developers would prescribe as to how subjects should explore an area. Accordingly, we conducted a number of field experiments in a nearby precinct which is a historically significant area

known to be of interest to tourists and locals alike.

The mobile information device we used as a kind of technology probe is a modified version of a mobile game client developed at [removed for reviewing] for helping first semester students become familiar with their new



learning environment (e.g., [reference removed for reviewing]). mExplore is implemented as a client-server model. Its mobile client part runs on a Windows Mobile based HP PDA. Usually the client connects to the respective server via WiFi (wireless Internet) connections. WiFi is also required by the internal positioning engine.

Apart from providing basic location information (a transparent aura is projected onto a map of the area to indicate the tourist's current location) as well as object-related information functionalities similar to other mobile guide systems, the mExplore prototype also provided functionalities we consider essential for supporting reflective exploration:

1. Textual, audio and photo annotations

A popular aspect of exploring is creating/maintaining representations allowing tourists to reconstruct what they experienced during a journey and also to reflect upon their experiences. mExplore supports the creation of digital representations by offering users to capture written comments, verbal comments and digital

pictures. Using pictures for reflection is supported by mExplore by automatically associating pictures and the location where they were taken.

2. Past route visualization

mExplore tracks the user's location while he or she explores an area of interest. The data is used to visualize, as a thin red line, the tourist's past route. Combined with the digital representations created by the user, past route information can be a powerful resource for reflection.

We are not saying reflective exploration cannot be supported by paper-based guidebooks (written annotations; drawings on maps). We do think that a mobile device like mExplore offers additional opportunities which we aspired to explore by deploying mExplore as a technology probe.

DEPLOYING mEXPLORE

Mobile activity took place in the city of Hobart, Australia in the historically significant Battery Point precinct. The location was selected because Battery Point is one of Hobart's prime tourist locations and offers ample opportunities for exploration even if visitors are already relatively familiar with the area. Seven out of eight participants (seven males, one female) were in their 20s; one female in her late 30s. All were currently enrolled at the local university and were recruited via an invitation emailed to Hobart-based honours and higher degree research students (the university operates three campuses across the state of Tasmania). Details of the experiment and ethical aspects including the ethics clearance we obtained from the university were discussed prior to the experiments during a recruitment meeting held on campus.

All participants had been to Battery Point area before and rated their familiarity with the area as about medium in average. Further briefings as well as an introduction to the mobile devices used were held prior to the experiment at a central location in Battery Point. Each participant was told they would have about half an hour they could spend exploring Battery Point. They were also told explicitly that it is up to them as to how they would spend the time, resulting in quite diverse exploration routes.

Because of a lack of WiFi coverage in the Battery Point area, we implemented a Wizard of Oz approach to location awareness. This means each participant was followed by a "wizard" using a laptop to update every few seconds, via a WiFi ad-hoc network, the participant's location as shown on

his or her PDA. This way we ensured that the participant's PDA would always reflect the participant's current location.

Once participants finished their exploration activity we asked them to provide some verbal feedback and also requested filling out forms covering aspects, such as general impressions regarding the mobile information system they just used, more specific usability aspects as



well as few technical issues. Forms also offered an opportunity for providing further free form comments.

Apart from the questionnaires, data collected during the field experiments includes comprehensive location data describing the routes taken by participants, photos and audio recordings taken by participants as well as photos taken by a second wizard shadowing participants. Because of the real world setting and the lack of continuous video recording of participants, monitoring of participants had been incomplete at times.

DISCUSSION OF FINDINGS

Researching reflective exploration we were specifically interested in the usability and usefulness of the textual, audio and photo annotations and, in particular, the past route information (which of course builds on mExplore's location awareness functionality).

Part I: usability and usefulness

We used a post-experiment questionnaire to find out if participants liked the functionalities offered by the mExplore prototype. Generally, feedback regarding mExplore was clearly positive. All participants stated they would like to use such a system when exploring other locations. They rated re-use of the system at 4.13. A written statement by one of the study participants appears to be representative of the overall impression:

"I liked the software, it was easy & fun to use. I would use it if I was in a new city or especially in a new state / country."

In terms of ratings, the positioning function (4.54) was rated best among the functionalities provided by mExplore. Participants also rated the map and the position visualization highly (4.55). The following comment by a participant seems to summarize the general impression:

"Map and location feature probably the most useful part of the system."

At 4.38 the positioning function was rated nearly as highly as the positioning function itself.

We expected that the new past route visualization would help participants understand what parts of the area of interest they already explored and what parts they hadn't visited as yet. Feedback from study participants suggests participants actually valued the past route visualization:

"Movement history is also very useful, as you can see where you haven't been yet"

The following comment supports our assumption regarding the usefulness of the history visualization:

"The system could be really cool for people revisiting the site some time in the future-to re see the places they liked, and avoid places they disliked, also allowing them to go on new routes"

Cross checking statements with the actual routes taken by participants during the experiments reveals no participant visited an area twice.

Regarding usage of the different annotation functions offered by the prototype, participants created 54 annotations during the experiments. The most frequently used annotation functionality was taking a digital picture (27 annotations) followed by voice recordings (16 annotations) and text input (11 annotations).

Offering digital pictures and digital audio recordings input as alternative -and possibly more efficient- input modalities did not mean participants abandon textual input. Interestingly, one participant used the audio annotation function to augment photos. Every photo taken by this particular participant was accompanied by an additional audio annotation describing what the photo actually shows as well as information about the context of taking the picture. Feedback provided in the free form section of the post-experiment questionnaire points towards the motivation for doing so:

"I thought having photos & voice was terrific you could record why you took a photo, very valuable when you return from a holiday and you have all these photos of old buildings and you are not sure where or why you took it"

Comparing audio and textual annotations reveals another unexpected result. The three participants who used audio annotations did not use the textual annotations (except for one single text annotation). In the free form feedback section they explain:

"The sound recording feature was more useful than [sic] the written annotation as you can record your comments a lot quicker. It would be a useful feature if you were in a hurry."

"I would get rid of the annotation in favor of voice messages they're quicker and easier"

"I think the voice recording is better than the annotation. I think on-screen keyboards are too fiddly, especially for people unfamiliar with PDA use."

The point is also supported by the fact that the three participants who used the audio annotation function produced a much higher number of annotations than participants who used the text annotation function. This suggests that the voice recording function is indeed easier and faster to use than text input.

However, interpretation of this result is not as straightforward as it may seem. Participants who used text annotations did not use audio annotations at all. Feedback from one of the audio annotation users as well as from previous, unrelated experiments with similar devices (e.g., [reference removed for reviewing]) suggests that this form of annotation may be difficult to use and may also be inefficient. We believe a verbal comment by one of the participants (quoted from memory) helps explain this phenomenon:

"I don't like the voice recording function because I don't like to hear my own voice"

Anecdotal evidence suggests that quite a few people do not like video or voice recordings of their own. This helps explain as to why a number of participants did not use the audio annotation function even though using it may be much more efficient than textual input.

Part II: usefulness beyond usability

In addition to being perceived as useful the past route visualization function also appeared to help participants orientate themselves, and thus navigate, in a very profound way as they *did not* exhibit behaviors one of the authors observed during previous unrelated experiments [reference removed for reviewing]. During these experiments one of the authors observed that subjects using a predecessor of the mobile information system we used often paused for a little while when approaching crossroads, apparently because they lost their orientation. He could then observe how participants aligned the digital map provided by their PDA and their line of sight when deciding where to go next. During our "history-enhanced" experiments at Battery Point we did not observe such behavioral patterns. Assuming we haven't observed an artifact resulting from participants' moderate familiarity with the area we had to broaden our search for an explanation.

For a plausible but still very preliminary explanation we draw from insights into insect navigation. Ants and bees have shown to support their visual memories more preparedly than humans during their excursions in the world. Like humans insects use landmarks as part of a repertoire of navigation strategies when they forage for prey or nectar. Unlike humans, in many circumstances they "turn back and look", accounting in their strategies that landmarks will not look the same on the way home as they did on the way out:

"An interesting but, as yet, largely unexplored area is the extent to which navigational information relevant to travelling a route in one direction can be acquired while travelling in the opposite direction. [...] Although the views needed to guide the outward and homeward trips are usually very different, by turning back and walking towards a landmark that it has just passed, an ant on its outward trip could, without much extra locomotion, acquire views to guide its return. Indeed, experiments on bees flying through tunnels suggest that local vectors for the homeward trip might be learnt on the outward trip" (Collett et al. 2003, p. 723).

Humans are not incognizant that they encode and recognize landmarks based on their egocentric experiences; however, pursuing movements to learn about landmarks does not seem to be a natural wayfinding activity. This means there might be scope for supporting respective behaviors through smart technology design and providing a representation of the route just followed is possibly a first step into this direction.

CONCLUSIONS AND FUTURE RESEARCH

Deploying the mExplore technology probe in a realistic, tourism-relevant environment allowed us to collect valuable data and provided us with interesting insights into ways to support reflective exploration.

One of the next steps in this research is to repeat some of the experiments involving genuine tourists exploring areas they are not familiar with. Negotiations with the relevant stakeholders are well under way.

Overall the data regarding different functionalities, in particular the annotation functionalities, suggests that it is important to offer a range of different annotation modalities. Each participant in the experiment used the range of annotation functionalities available in a different way. Participants were happy to use different functionalities as the mExplore prototype does not constrain usage more than it is advised from a technical point of view. We believe flexibility is also one of the reasons as to why participants generally liked using mExplore. Further expanding what is offered by respective functionalities includes investigating different ways to personalize points of interests. As yet mExplore supports only generic points of interests which means that each user sees the same set of points of interests. Personalized points of interest will be derived from participant profiles which means previous visits to an area (or even visits by friends) could be considered.

A major contribution is the finding that mExplore's past route visualization function appeared to help participants orientate themselves, and thus navigate, in a very profound way. Our preliminary, but nevertheless intriguing, explanation draws from insights into insect navigation. We suggest exploring the use of mobile information devices to offer and support an analog to a wasp's "learning flight". That is assist humans in building up their knowledge of an unfamiliar environment much like that afforded by an

insect's specialized behavior during her initial excursions from her nest. We are interested in considering whether this behavior can inspire designing mobile information systems to help tourists understand the environment they are exploring. "Looking back" at a nest, in particular, seems to help insects in finding the way back to the start of a journey:

"Rapid learning is possible because insects are preadapted to acquire the appropriate information (e.g. views of landmarks near to a goal), and they have evolved specialised behaviour, such as learning flights, for acquiring it." (Collett et al. 2003, p. 723).

We could envision a number of tourists who would appreciate technology support that helps them return to their "nest" once they finished their daily exploration without having to check maps or other navigation aids (which would most likely terminate any flow experience). After all, this kind of support could become a core aspect of what we call reflective exploration.

Developing a system that promotes "looking back" every now and then is not as trivial as it may first appear. The system needs to incorporate knowledge of the varying visual impressions of certain landmarks from different points of view (POV) (e.g. Bidwell 2004). Our related work on ego-centric navigation and the manner in which people build up and communicate knowledge of landmarks from different POVs as they wayfind (e.g. Bidwell and Lueg 2004; Bidwell, Lueg and Axup 2005) is therefore an invaluable asset in developing the system.

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