Elicitation of User Requirements for Mobile Interaction with Visual and RFID Tags: A Prototype-Based Exploratory Study

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Abstract. This paper presents a preliminary prototype-based elicitation of user requirements for mobile interaction with a public display using visual and RFID-tags. The study is based on the use of a demonstration and two applications scenarios as means for encouraging user requirements elicitation. The results show that the prototype, its demonstration and the examples of possible applications are very useful for the users: they express a large number of requirements, which, are furthermore, quite original.

Keywords: Emerging Technologies, Innovation, Mobile Interaction, Prototype Evaluation, User Requirements, Visual Tags.

1 Introduction

Relating the physical and virtual worlds using mobile phones is now a widely-accepted interaction paradigm for providing ubiquitous computing services. Several factors, related in a number of papers in the area, could explain this tendency. First, continuous innovation in mobile devices (e.g. miniaturization, diminished energy consumption) enabled the development of relatively usable technology with a lot of features and important computing power. Second, mobile devices have become extremely common and wide-spread. Third, they are usually carried by their owner and could thus be used at almost any moment of place and time. Forth, if equipped with a camera, they could read visual tags placed on physical objects and thus interact with these objects. If equipped with a Radio Frequency IDentification (RFID)-reader, mobile device could also read RFID tags. Because of all these factors, mobile phones in combination with visual tags or other identification technologies are considered as the most common alternative for accessing ubiquitous computing services and interacting with smart environments.

However, most of the research efforts in this area up to now have been concentrated either on creating new technological concepts and, eventually, services or on

M. Kurosu (Ed.): Human Centered Design, HCII 2009, LNCS 5619, pp. 159–166, 2009.

evaluating the usability of existing systems. Less work has been done on the utility of these services and systems. Understandably, less work has also been done on detailed user requirements, whose elicitation and analysis is a prerequisite for providing a useful service.

The study presented in this paper is a contribution in this direction. The paper is structured as follows. We first discuss briefly the related work on mobile interaction with visual tags and on the elicitation of user requirements for emerging technologies. Then, we present the design of the study and its results. Finally, we discuss these results and open up some perspectives for our future work.

2 Related Work

As mentioned earlier, most of the work on mobile interaction with visual tags has been centered on creating new technological concepts or services. Thus, in the CoolTown project, users could read additional information about the current exhibition in a museum scanning the pieces of art using a PDA [1]. In the Aura project, a similar concept was put forward: with their PDA, users could read barcodes placed on existing products to get additional information on them [2]. Other, already commercialized, applications have been proposed, in which users could scan visual tags with their mobile phones to download mobile content [3], to retrieve bus timetables [4], and to record someone's personal details coded in a visual tag embedded in his business card [5].

Considerable work has also been done on the usability of these interaction concepts. The understandability and the intuitiveness of the concept, the speed at which the tag must be decoded by the tag reader and the speed and accuracy of user's clicks on the tag have been evaluated [6]. The authors showed that the participants understood and interacted successfully with the system after only 15 minutes of training. As for the speed, novice users could click on the visual tag quickly and accurately. Also, the usability of pointing and gestural interaction has been studied [7, 8]. It has been shown that the interaction is natural and gestures are correctly recognized and recalled if not too complex.

However, less work has been done on the utility of mobile interaction with visual tags and on the user requirements for such services. One example in this direction is an extensive field study done by [8]. It is based on 23 interviews and 370 hours of observations of field biologists' practices experimenting on tropical plants. The study gave very rich results and motivated the design of ButterflyNet, a mobile capture and access system that integrates paper notes with digital photographs captured on the field. Because of the user detailed user requirements analysis and the early user implication, the new ubiquitous computing system has been successfully adopted by field biologists.

We should note that user requirements analysis for emerging technologies such as mobile applications for ubiquitous computing differs from user requirements analysis for more traditional technologies, because future users do not know and do not imagine the technology itself and the possible services that it could provide. Consequently, they have problems when expressing requirements for such technologies and services [9]. One possible solution to these problems is the use of prototypes and scenarios which are relatively concrete representations of future emerging technologies. Their

concreteness facilitates users' understanding of abstract, unfamiliar or fuzzy technological concepts. In this sense, scenarios and prototypes may help people become aware of and formulate some of their unconscious requirements. Furthermore, prototypes and scenarios help building a common discussion basis for all stakeholders and thus facilitate the reaching of an agreement in the early stages of a project [10].

The above-mentioned assumptions were the starting point of the exploratory user study presented in this paper. Its major objective was to establish a number of high-level user requirements for a future technical system, based on mobile interaction with visual tags. The elicitation of user requirements was done using a low-level prototype and a number of textual scenarios.

3 Design of the Study

3.1 The Tested Prototype

The low-fidelity prototype, which has been evaluated, consisted in a public display capable of presenting both public and personalized information to people in its proximity (Fig. 1).

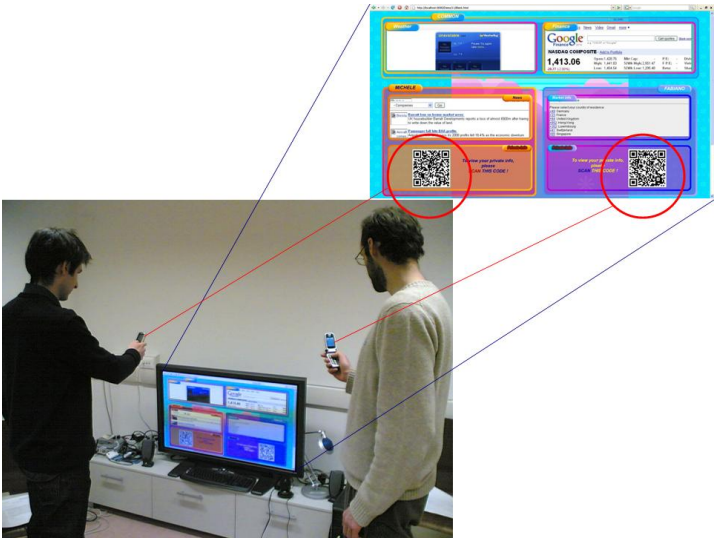

Fig. 1. Users interacting with the tested prototype

During the test, the public information presented was a weather forecast for the region, in which the study was done as well as some general financial information. As for the presentation of personalized information, it was based on the user's profile [11]. The user profile includes a user-ID, some general information and layout preferences (e.g. news, weather, colours, etc.), as well as some privacy and location-sensitive information hidden as a 2D visual tag on the public display.

When no identified users are nearby, the display shows general purpose location-based and weather information. When one or more users are identified in proximity of the display through their RFID contactless badge, the public display adapts its content and layout based on nearby users' number and identities. Privacy sensitive information can be viewed by users in their mobile phone by taking a snapshot of the visual tag on the screen.

3.2 Participants

Eighteen people (13M, 5F) aged between 23 and 42 years (M=34) participated in the study. They were all working in the institute developing the application. However, none of them was familiar with the concept or the tested application before the actual user tests.

Half of the participants had an engineering background and half were administrative personnel. None reported difficulties with vision or motor skills. All of the participants had personal mobile phones, using them mainly for calling and sending SMS. All but two of the participants had no prior experience with visual tags. The participants, who had seen visual tags before, had a vague idea of their application and usage.

3.3 Procedure

The study comprised 3 major steps. First, the future users were questioned about their familiarity with mobility interaction with visual codes. Two general questions about the potential applications of these technologies were also asked. Then, 2 usage scenarios (a payment scenario and a timetable retrieval scenario) as well as a demonstration of the functioning of a low-fidelity tag-based prototype were presented. Finally, we asked a list of more concrete questions of the application and the perceived utility of mobile interaction with visual tags. Two experimenters were conducting the study. One of them was focusing on the presentation of the scenarios and the demonstration, while the other was asking the interview questions and tape-recording subjects' answers.

3.4 Data Analysis

The verbal protocols obtained, transcribed verbatim, were then analysed using classical techniques for theme-based protocol analysis. The unit of analysis corresponded to an idea of potential application expressed by a subject. The main ideas evoked by future users concerned the use of visual tags for the identification of goods and people; for getting dynamically updated location-information in unknown environments; for facilitating complex data visualization using a large display; for displaying private information in shared spaces; for displaying private information in confidential contexts. Subjects' ideas were also classified according to their originality compared to the proposed scenarios, the demonstration and the participant's previous knowledge of this interaction concept.

4 Results

4.1 General Results and Types of Applications Proposed

One hundred and seventeen requirement were collected (Min=3, Max=13, M=6,5 requirements per participant). The participants with engineering background expressed almost the same number of requirements (N=66, M=7) as the participants with non-engineering background (N=51, M=6).

The big class of applications proposed most often was the one of technologies protecting privacy (in 38% of user requirements). Here are some typical examples of such applications:

In a home environment: *"I would like to use a combination of mobile phone and visual tags in a home environment. In this way, you could read some information, which should not be seen by your partner or your children…But this probably doesn't make any sense…"*

In a public space where visualisation of private information is necessary: *"One could use this technology in hospital, for visualizing personal information. I think this could be very useful. You can code the health record, which could be read only by authorized doctors and visitors. The tag could be put on the bed of the person who is ill. In this way, one can avoid that all the other people in the room could see the information. The public display could be used to present public information such as the plan of the hospital building and the location of different services."*

For personal and confidential information: *"The visual tags could be used for codifying credit cards details. I think it will be more secure than having a credit card with your details on it.'*

Another big class of applications that was proposed quite often was the one of technologies for giving additional information than the one usually presented on an object or in the physical environment (in 30% of the cases). Again, here are some typical examples of such applications:

Additional information on goods: *"Tags could be used to provide information on the content of products...We could know what we eat, could see whether we have some allergies to some substances. Another example is information on how to take a medicine. This could be very useful for some drugs which may soon be sold in supermarkets in our country.*"

Additional information on services: "*In a university building or campus, the time schedule of seminars or conferences could be shown on a public display, while your private information could be encoded in visual codes."*

Additional location-based information: *"Could be interesting for…gaming. I would imagine putting the tags around the city and do some storytelling. One could use the visual tags in order to give some location-based clues which should be understood by gamers. People could go around and find the right information at a certain moment".*

Some participants proposed the use of mobile phones reading visual tags for the identification of products and people (15% of the user requirements). Examples of such applications are proposed below:

Identification of people: *"It may be used by people who have illnesses like Alzheimer and who can get lost. The code, which could be worn by the person, will encode private information like name, address and could be read only by relatives, public authorities or medical personnel"*.

Identification of products: *"At home I would like to be able to install such codes on the goods that I had bought from the supermarket to know when they were bought"*.

The participants also wanted to use the visual tags to encode some private information, preferences and interests in order to create personal profiles, which could be exchanged with friends or new acquaintances (11% of the requirements). In 6% of the cases, people expressed requirements for the use of the large display for displaying complex visual information. An interesting example of such an application is the following one:

"It can be somehow useful in situations in which you need to store plenty of information, rapidly and in a very "hard" environment. I'm thinking about refugees' camps or some humanitarian actions in developing countries. The advantage will be to use only one tool and spare some material resources in this way, especially for big databases where you need multiple views of the situation of each person or family."

4.2 The Role of the Scenarios and the Demonstrations

We evaluated the role of the concrete representations of an emerging technologies (i.e. application scenarios and demonstrations) based on the number of the requirements expressed by participants, the originality and the concreteness of the applications proposed and their usefulness for the redesign of the prototype. The results are presented below.

Number of Requirements Expressed. The demonstration of the prototype and the two application scenarios described by one of the experimenters seem to have a positive influence on the number of requirements expressed by the test participants. Thus, a total of only 33 requirements (28% or 2 requirements per person on the average) were expressed before the demonstration and the presentation of the scenarios (i.e. before the users had acquired a concrete idea of the application domains and the potentialities of the technology). On the contrary, 84 requirements (72% or 5 requirements per person on the average) were expressed after the scenarios presentation and the demonstration. This difference is particularly notable for the people having a non-engineering background. They expressed a total of only 8 requirements (14% of the requirements expressed by non-engineers) before having been presented with concrete examples of applications and 43 requirements (84%) after the demonstration of the prototype and the scenarios presentation. Tough less important, the contrast "before demonstration" vs. "after demonstration" is also observed for participants with an engineering background (38% of requirements before vs. 62% of requirements after demonstration).

Originality of the Proposed Applications. The originality of the applications proposed by the test participants was also evaluated by two of the three authors of the paper. In order to evaluate the originality of an idea, we compared it to the scenarios described during the test, the demonstration and the participant's previous knowledge

of the interaction concept. The demonstration of the prototype and the exemplification using application scenarios do not seem to limit the participants' imagination. The ratio "original ideas vs. non original ideas" is exactly the same before and after the demonstration. Thus, before the demonstration users expressed 14 ideas of applications judged original by the authors (42%) and 20 ideas judged not very original (58%). The situation is exactly the same after the demonstration (36 ideas, 43% vs. 48 ideas, 57%).

5 Discussion and Future Work

The results show that future users express much more requirements after having getting acquainted with the application scenarios and seen the demonstration using a concrete representation of the future technology. In addition, the requirements elicitation aids do not seem to limit the participants' imagination. The ratio "original ideas vs. non original ideas" is exactly the same before and after the demonstration.

There are at least three possible interpretations of the first result showing an increase in the number of the expressed requirements after the demonstration. First, users have longer time to think about the same topic. Thus, they can have more ideas to propose. Second, these ideas clarify in the discussion with the experimenter, i.e. the requirements are constructed in the collaboration with someone who has a clearer idea about the possible applications of the technology. Third, the concreteness of the demonstration and the scenarios may have a positive influence on the understandability of the technology, and, consequently, on the number of user requirements expressed.

As for the result on the relative originality of the expressed requirements, we think that this may be due to the low-fidelity of the prototype and the openness of the proposed scenarios, which did not include any very concrete interaction sequence or task. Thus, user's imagination was supported and stimulated rather than limited to one or two possible solutions.

This preliminary study showed that scenarios and prototypes may be very useful tools for the social construction of user requirements. However, further more experimental studies are needed in order to get insight into the factors accountable for the facilitation of user requirements elicitation.

Acknowledgments

We would like to thank Iulia Ion, Boris Dragovic and Aleksandar Milosevic for designing the prototype as well as for the useful comments on this work.

References

1. Kindberg, T., Barton, J., Morgan, J., Becker, G., Caswell, D., Debaty, P., Gopal, G., Frid, M., Krishnan, V., Morris, H., Schettino, J., Serra, B., Spasojevic, M.: People, Places, Things: Web Presence for the Real World. In: 3rd IEEE Workshop on Mobile Computing Systems and Applications. IEEE Press, New York (2000)

2. Smith, M., Davenport, D., Hwa, H.: Aura: a Mobile Platform for Object and Location Annotation. In: Adjunct Proceedings of International Conference for Ubiquitous Computing (2003)
3. Bango Ltd. Bango Spots Link Camera Phones Straight to Mobile Content, http://bango.net/
4. High Energy Magic Ltd. The Spotcode Framework, http://www.highenergymagic.com/
5. Masnik, M.: Mobile Barcode Scanning Catching on in Japan, http://www.thefeature.com/article?articleid=100700&ref=5960372
6. Toye, E., Sharp, R., Madhavapeddy, A., Scott, D., Upton, E., Blackwell, A.: Interacting with Mobile Services: an Evaluation of Camera-Phones and Visual Tags. Pers. Ubi. Comp. 11, 97–106 (2007)
7. Ballagas, R., Rohs, M., Sheridan, J.: Mobile Phones as Pointing Devices. In: IEEE Pervasive 2005, Workshop on Pervasive Mobile Interaction Devices. IEEE Press, New York (2005)
8. Yeh, R.B., Liao, C., Klemmer, S.R., Guimbretière, F., Lee, B., Kakaradov, B., Stamberher, J., Paepcke, A.: ButterflyNet: a Mobile Capture and Access System for Field Biology Research. In: ACM CHI. ACM Press, New York (2006)
9. Anastassova, M., Mégard, C., Burkhardt, J.-M.: Prototype Evaluation and User-Needs Analysis in the Early Design of Emerging Technologies. In: Jacko, J.A. (ed.) HCI 2007. LNCS, vol. 4550, pp. 383–392. Springer, Heidelberg (2007)
10. Mannio, M., Nikula, U.: Requirements Elicitation Using a Combination of Prototypes and Scenarios. In: WER, Buenos Aires (2001)
11. Morales-Aranda, A.H., Mayora-Ibarra, O.: Adaptive Information Visualizations in Public Displays for Multiple User Profiles. In: Workshop on Knowledge-based User Interface (2007)