
Expected User Experience of Mobile Augmented Reality Services

Thomas Olsson
Tampere University of Technology
Unit of Human-Centered
Technology
Korkeakoulunkatu 6
33720 Tampere, Finland
Thomas.olsson@tut.fi

Kaisa Väänänen-Vainio-Mattila
Tampere University of Technology
Unit of Human-Centered
Technology
Korkeakoulunkatu 6
33720 Tampere, Finland
Kaisa.vaananen-vainio-
mattila@tut.fi

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Abstract

To ensure the acceptance of mobile augmented reality (MAR) services in the future, their development should be based on knowledge of expectations of potential end-users. We have researched this with multiple methods in various cases. This paper summarizes our findings from an *experiential* point of view: What kind of experiences are MAR services expected to evoke? This knowledge can be used when setting UX targets for user-centered design of MAR services.

Keywords

Mobile computing, augmented reality, user expectations, user experience, user-centered design

ACM Classification Keywords

H5.1. Multimedia Information Systems: Artificial, augmented, and virtual realities; H1.2 User/Machine Systems: Human factors.

General Terms

Human factors, Experimentation

Introduction

Gradually, our personal mobile devices are transforming into external eyes and ears for sensing the embedded digital information in the ambient

environment. *Augmented Reality* (AR) as an interface to such information is becoming a central approach in creating new applications for *ubiquitous computing* and *ambient intelligence*. AR overlays digital information to the user's perception of the physical world so that they appear as one environment [8]. *Mobile augmented reality* (MAR) services work anywhere, adding a layer of interesting information to be intuitively interacted with via the surrounding objects, places, or people. MAR can be applied in various applications areas, ranging from navigation, shopping and tourism to entertainment, gaming and social interaction. This potential creates great possibilities but also challenges for designing a pleasurable user experience.

Providing rich, stimulating, and pleasurable user experience (UX) [3] is becoming a central goal and design strategy in design of interactive technology. User experience is subjective, depends on the context, and develops over time. The nature of the experience can be, for example, pragmatic, emotional, symbolic, aesthetic, or identification [2][3]. UX moves beyond usability (effective, efficient and satisfactory interaction with the product) towards more emotionally appealing relationship between the user and the product. Thus, the design focus moves from removing negative factors like bad usability or functionality problems to offering positive experiences that surpass the user's expectations. In this sense, MAR provides its users with novel technological tools and ways of interacting with the surrounding world, which could enable rich, even unparalleled, experiences and emotions. Research around user experience and expectations of MAR, much less creating guidelines for designing MAR services, however, has been very limited [1].

Our Approach and Research Cases

The starting point of our research is that the development of MAR services should concern also the UX of these services. We aim at understanding the potential end-users' central expectations of MAR services, especially from an experiential point of view. We want to elucidate what specific elements of UX are such that MAR is expected to enable or catalyze, as well as how different technological components in MAR influence the user experience.

For this target we have conducted user research with various qualitative and quantitative methods: 1) focus group interviews with various user groups [4], 2) interviews in a shopping center context for MAR services [6], 3) online survey with over 250 respondents evaluating MAR scenarios [5], and 4) a diary study to gather potential user's needs for location-specific annotations [7].

Work-in-Progress: MAR UX Framework

Based on the different research cases, we have identified various characteristics of user experience that MAR services are expected to be able to create or catalyze. In Table 1 we summarize the experiences, structured under different aspects of the service that the experience would mostly be related to (functionalities, content, interaction). Furthermore, we reflect how the expected experiences relate to different components of MAR technology that could initiate, enable, or catalyze the experience. These are 1) Mobility in general, 2) Context-sensitivity, 3) Embedded information, and 4) AR output.

Table 1 Summary of the Characteristics of Expected MAR User Experience and Technology Components which Enable, Initiate or Catalyze Them. Summarized and Synthesized Especially from [4][5][6].

<i>UX characteristic</i>	<i>Description of the experience</i>	<i>Technology components</i>
<i>Experiences originating mainly from Service functionalities</i>		
<i>Efficiency</i>	Efficiency in ad hoc information retrieval in various contexts: saves time and effort and facilitates performing everyday tasks	AR, Embeddedness, Context-sensitivity
<i>Empowerment</i>	Gaining new practical benefits by enabling novel activities and sources of information, and augmenting human perception and memory	Embeddedness, Context-sensitivity
<i>Increased Awareness</i>	Increased awareness and of one's surroundings and the digital affordances in it, thus creating feelings of discovery and insight	AR, Embeddedness, Context-sensitivity
<i>Inspiration</i>	Feeling of being encouraged, cognitively stimulated and eager to try new things or appropriate the service for new purposes	AR
<i>Motivation</i>	Feeling of being more motivated to participate or to do tedious tasks as results of the novelties in MAR (e.g. way of interaction, proactivity)	AR, Context-sensitivity
<i>Surprise</i>	Positive surprises and wonder due to surpassed expectations and receiving extraordinary information automatically	Context-sensitivity, Embeddedness
<i>Experiences originating mainly from Information content</i>		
<i>Connectedness</i>	Feeling of having novel ways for social interaction and being connected with and aware of other people using MAR services	Mobility, Embeddedness
<i>Collectivity & participation</i>	Sense of community, participation, and belongingness by collectively creating and producing AR content	Embeddedness, Mobility
<i>Creativity</i>	Creative, self-expressive and artistic feelings in creating AR content and in mixing the digital with the real world	AR, Embeddedness
<i>Liveliness</i>	The service and environment feeling vivid and dynamic because of constantly accumulating and updating content related to surroundings	AR, Embeddedness, Mobility
<i>Meaningfulness</i>	AR content feeling personally meaningful and relevant, as well as reliable, up-to-date and corresponding to the real world objects	Context-sensitivity, AR
<i>Playfulness & entertainment</i>	Feelings of joy, amusement and playfulness that arise from intriguing and rich content as well as novel ways of interaction	AR, Embeddedness
<i>Experiences originating mainly from Interaction with the augmented reality</i>		
<i>Captivation</i>	Feeling of being immersed and captivated in the interaction with the AR	AR
<i>Intuitiveness</i>	Feeling of naturalness and human-likeness in interacting with the AR information and intuitiveness of how AR content is aligned to real world	AR, Embeddedness
<i>Tangibility</i>	Feelings of concreteness and coherence of environment-related content, which lead to senses of presence and unity with the surroundings	AR, Embeddedness

Descriptions of the technology components:

AR: characteristics of augmented reality as the system output and the way of interacting with AR content

Embeddedness: real-world objects being embedded with or linked to additional digital content ("internet of things")

Context-sensitivity: service functionalities and content being determined by and adaptive to the user's context (e.g. location, social surroundings)

Mobility: the experience is possible with any kind of mobile services or with information technology in general, that is, the experience not being as much dependent of AR

Based on our studies, we conclude that the UX with mobile augmented reality services is expected to be very multifaceted, and affected by a diverse set of components of enabling technology. The expectations were partly attributed to other technologies than AR as such. Overall, MAR has great potential of facilitating pleasurable user experience with positive emotional reactions. By meshing places and objects with digital content, mobile AR services could provide the user with information that is contextually personally meaningful, collectively created, inspirational, captivating, and pleasurable at the specific moment.

Discussion and Future Research

The identified UX categories can serve as experience-oriented targets in the design of future MAR services. However, it is a challenge to find concrete ways to disseminate and utilize the knowledge about users' expectations of MAR, and bridge the UX understanding to design practices. At this point, it is too early to compose very concrete design guidelines that would lead to a certain pre-defined user experience: as a concept, UX is very subjective and dependent on the context. We need more understanding of what is the added value of AR in the UX of such holistic MAR services, and thus what are the most AR-specific expectations. This requires controlled experimental research setup with functional MAR services. As next step, we will use this framework as basis in designing evaluation metrics, with which we will evaluate the UX of current MAR applications like as Layar and Junaio. This allows us to examine to what degree the expectations have been met and how significant the expected UX characteristics actually have become in using such first publicly available MAR applications.

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