Adaptivity in Ubiquitous Systems: An Experimental Study

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Abstract. In many projects it is assumed that adaptivity is a good thing, often without a solid reason for explaining why it would be desirable. We have built a ubiquitous tangible system to study how users respond to adaptive system and how they perceive different types of adaptivity. In this presentation we report the early study results.

Keywords: ubiquitous system, recommender system, storytelling, user study

Introduction

The experience of adaptivity in entertainment applications is a largely underexplored and under-theorized area. In many of the research projects dealing with developing an adaptive component, it is assumed that adaptivity is a straightforwardly good thing and that more personalized content or a more tailored interaction is something that the user will appreciate. However, adaptive effects can appear to be random or nonsensical to the user, causing them to believe the system is malfunctioning or poorly designed [1]. Frequently, adaptivity is pursued without a solid reason for explaining why it would be desirable, or how specific kinds of adaptivity can be achieved. Grounding adaptive design in established theories of how people differ from each other and how these differences might be addressed has met with only mixed success, such as with information delivery systems aimed at adapting to a user's cognitive or learning style [2].

The Reading Glove project studies the notion of adaptivity, specifically within the realm of tangible and ubiquitous systems. In educational and workplace applications, where adaptivity is typically task-oriented the adaptive mechanisms can be much more explicit, intervening directly with the user to offer them assistance or advice. In ubiquitous environments, however, the nature of the interaction with technology shifts. Computational elements are embedded in the environment or in smaller, handheld devices. Users may not be paying explicit attention to the system, and the activities taking place are less task-oriented. Some of the most common uses of adaptivity in ubiquitous spaces are for leisure activities, such as museum guide systems that combine entertainment with education, or domestic systems that automate or anticipate common user behaviors [3, 4, 5, 6]. Since users of these systems are less focused on interacting with the technology itself, the goal of the

© Jelínek J., Jiroušek R. (Eds.): Znalosti 2011, pp. 259–262, ISBN 978-80-248-2369-0.
VŠB–Technická univerzita Ostrava, Fakulta elektrotechniky a informatiky, 2011.

system is to unobtrusively monitor the users and adapt itself to suit them in some way. The novelty of this kind of interaction is a significant issue in constructing adaptive components that work as intended. The Reading Glove was constructed as a test environment to investigate the experience of an entertainment-oriented adaptive system by looking at the behavior of users while using the system as well as the ways they articulate their experience and their understanding of the system.

We implemented several recommendation strategies in the knowledge based recommender system utilizing rich ontological descriptions and rules. A large end-user study is currently on the way to investigate the effect of these recommendation strategies on users perception of the adaptivity of the system. This contribution will provide early results of this study as they become available in December 2010.

The Reading Glove

The Reading Glove is a wearable RFID device which allows readers to "extract memories" from tagged physical artifacts, thus engaging them in an audio-based interactive narrative.

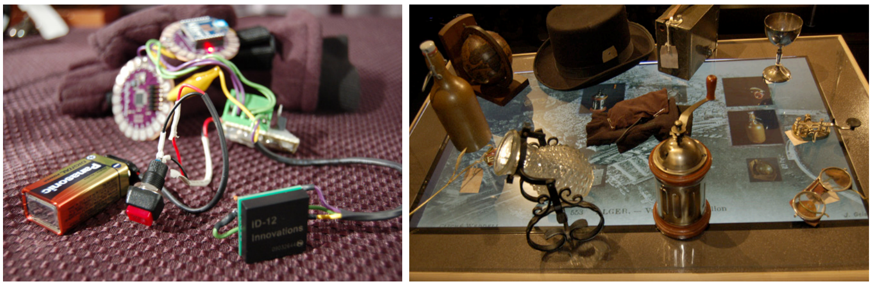

Fig. 1. Left: The components of the glove: Arduino Lilypads, XBee radio & RFID reader, Right: The 10 tagged objects on tabletop

The interface consists of a fingerless fabric glove containing an Arduino Lilypad microcontroller, an Innovations ID-12 RFID reader, and an Xbee Series 2 wireless radio [Fig. 1, Left]. A user picks up objects associated with the story, each of which has been tagged with an RFID chip [Fig. 1, Right]. When the RFID reader in the palm of the glove detects a tag, the tag ID is communicated wirelessly to a laptop running MaxMSP. This triggers the audio playback of recorded story fragments associated with the object being handled. Technical and interactive elements are described in [7].

The Reading Glove's story is an espionage thriller about a spy who is forced to go on the run when his cover is blown. It includes several twists and surprises, and ends with him discovering – too late – that his own agency is involved in the plot to sell him out for political gain. Each tagged object is associated with two story fragments, ranging in length from 17 to 42 seconds. The total story takes 8 minutes and 50 seconds if played straight through, although when the story is encountered via the system, it is played in a random order and at least some of fragments are likely to be played multiple times. Further details on the design of the narrative content can be found in our previous paper [8].

A user using our system is presented with a collection of artifacts arrayed on a table. The artifacts each have a tag attached to them, much like items in a museum or at an estate sale. The reader may pick up any of these objects, and explore its weight, its texture, its scent, and any mechanically interactive elements and moving parts that it might have. Should the participant bring the palm of the gloved close to the tag on the object, a chime will sound and a piece of narration will playback, in which the object is prominently featured. Navigating the narrative consists of selecting objects in order to experience their physical properties, and to reveal the pieces of narration associated with them.

In addition to generating audio feedback, picking up an object also triggers the reasoning engine to generate a set of recommendations that will be shown to the user when the audio clip nears its completion. The reasoning engine is a rule-based expert system written in the Jess language. The reasoning component relies on an OWL (Web Ontology Language) ontology that encodes semantic knowledge about the story content, such as thematic connections between lexia and rankings related to the chronological order or the overall importance of specific lexia. The Jess rules use this knowledge base to recommend a set of three objects that will be most likely to advance the user's understanding of the story.

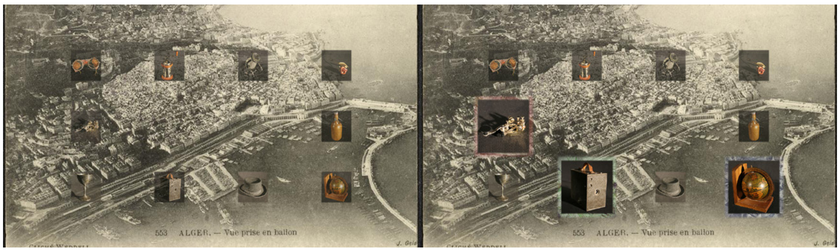

Fig. 2. The tabletop screen in neutral (left) and recommendation (right) states

Thus the recommender system acts as a kind of "expert storyteller", leading the reader through the narrative. There are 2 versions of the recommender that can be activated. The first version is a story-content based recommender that relies on knowledge of the story and the current lexia being listened to. The second version augments the story content with a user model, adding sensitivity to the individual reader's history and patterns of interacting with the system. The recommendations appear on the table several seconds before the end of the lexia. This delay is intended to focus attention on the story and objects rather than the display. When the recommendation system kicks in, the pictures of the recommended objects grow in size and become fully opaque (Fig. 2).

The Experimental Study

The study with over 30 participants is designed to answer several questions grouped into two areas. First, the study examines how users respond to the adaptive system from the following perspectives: do they find it usable and enjoyable; what actions do they take with the system; what kind of mental models do they appear to have constructed about how it works; how do they respond to the tangible and wearable aspects of the system? Secondly, we study how the users perceive different types of adaptivity: is one of the recommending methods preferred, or easier to use; do people notice the intelligence underlying the adaptive versions versus the random recommender; can they distinguish between the story-based recommender and the one that is also sensitive to their specific interactions?

To investigate correlations between the version of system used and the participant's behaviour and experience of the system, we used the Mann-Whitney test, which is non-parametric and does not assume normal distribution. We grouped the data from the two intelligent conditions versus the random condition. Correlation was found between the participant's condition (random vs. intelligent) and two experiential factors: the total number of lexia activated and the average number of times a lexia was activated. In the random condition, an average of 22.9 lexia were activated, which was significantly less than the average of 31.74 for the intelligent conditions; Mann-Whitney U=.035, z=-2.089, p<.05, r=-.39. Similarly, in the random condition, a lexia were listened to an average of 1.14 times, which was significantly less than the average of 1.6 times for the intelligent conditions; Mann-Whitney U=.021, z=-2.296, p<.05, r=-.43. We conclude that the intelligent version of the system engages users more than a random version.

References

1. Edwards, W. K. and Grinter, R. E. At Home with Ubiquitous Computing: Seven Challenges. G. D. Abowd, B. Brumitt and S. A. N. Shafer (ed.), Ubicomp 2001, 2001, 262-272.
2. Brusilovsky, P. and Millán, E. User Models for Adaptive Hypermedia and Adaptive Educational Systems. P. Brusilovsky, A. Kobsa and W. Nejdl (ed.), The Adaptive Web, 2007, 3-53.
3. Bellotti, V., Begole, B., Chi, E. H., Ducheneaut, N., Fang, J., Isaacs, E., King, T., Newman, M. W., Partridge, K., Price, B., Rasmussen, P., Roberts, M., Schiano, D. J. and Walendowski, A. Activity-based serendipitous recommendations with the Magitti mobile leisure guide. In Proc. 26th SIGCHI Conf. on Human factors in computing systems (Florence, Italy, 2008). ACM, 2008.
4. Kidd, C., Orr, R., Abowd, G. D., Atkeson, C., Essa, I., MacIntyre, B., Mynatt, E., Starner, T. and Newstetter, W. The Aware Home: A Living Laboratory for Ubiquitous Computing Research. N. A. Streitz (ed.), CoBuild 99, 1999, 191-198.
5. Kuflik, T. and Rocchi, O. User Modeling and Adaptation for a Museum Visitor's Guide. O. Stock and M. Zancanaro (ed.), PEACH-Intel. Interfaces for Museum Visits, 2007, 121-144.
6. Sparacino, F. The Museum Wearable: Real-time sensor-driven understanding of visitors' interests for personalized visually-augmented museum experiences. In Proceedings of the Museums & The Web (Boston, MA, 2002). Archives & Museum Informatics, 2002
7. Tanenbaum, J., Tanenbaum, K. and Antle, A. The Reading Glove: Designing Interactions for Object-Based Tangible Storytelling. In Proc. of the Augmented Human. ACM Press, 2010.
8. Tanenbaum, J., Tanenbaum, K., Seif El-Nasr, M. and Hatala, M. Authoring Tangible Interactive Narratives Using Cognitive Hyperlinks. In Proc. of the 3rd Workshop on Intelligent Narrative Technologies (INT3) at Foundations of Digital Games Conference (FDG) (Monterey, CA, 2010). ACM Press, 2010.