Designing Effective Mobile Augmented Reality Interactions

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Thesis Summary

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Abstract: This paper is an extended abstract of the doctoral thesis [1] which attempts to fill the knowledge gap between user understanding and available Augmented Reality (AR) technology, a result of the general lack of user studies in AR and high-pace technology-driven AR development. The thesis pursues this goal by: (i) reviewing perceptual issues that relate to handheld AR in order to identify usability issues; (ii) reviewing handheld AR system utility in order to propose utility improvements; (iii) conducting empirical user studies to explore identified usability issues; (iv) designing, building and evaluating solutions that will enhance handheld AR utility and usability.

Povzetek: Pričujoče delo je razširjen povzetek doktorske disertacije [1], ki strmi k zmanjšanju razkoraka med uporabnikom in tehnologijo dopolnjene resničnosti (DR) namenjene mobilnim napravam. Odtujenost je posledica pomanjkanja uporabniških študij DR in tehnološkega napredka, ki ne temelji na potrebah uporabnika. Predstavljeno dela poizkuša razkorak zmanjšati s: (i) pregledom percepcijskih problem in identifikacijo problemov uporabnosti; (ii) pregledom primernosti obstoječih sistemov; (iii) empiričnim raziskovanjem problemov; (iv) načrtovanjem in izdelavo izboljšav sistemov DR.

1 Introduction

The environment we live in is a dynamic heterogeneous space, filled with countless objects and people. This vibrant space is possibly the richest source of visual, audio and tactile stimuli that fabricates our everyday life experiences. Yet, we spend more time than ever interacting within digital media confined to screens, which often serve to disconnect us from the physical space we live in.

How can we escape the glow of the screen, and bring digital and physical worlds closer together, and how can we make the world itself a user interface for digital interactions?

Researchers raising these questions identified a possible solution in Augmented Reality (AR), an interaction concept based on superimposing computer-generated content on top of the real world. However, irrespective of the mass market reach through AR on mobile devices (e.g. handheld AR), the first generation of AR interfaces failed as online user survey conducted by Olsson and Salo revealed *"generally positive evaluations are overshadowed by mentions of applications' pragmatic uselessness in everyday life and technical unreliability"* [2]. This is the result of the general lack of user studies, coupled with high-pace technology-driven AR development, which increased the knowledge gap between the available technology and user understanding. This disconnect between technology and the user resulted in poorly designed AR implementations that did not take full advantage of AR paradigms.

The primary goal of this thesis is to reduce this gap between the user and the technology and improve the usefulness of future handheld AR interfaces where usefulness comprises of system utility and usability. Utility is concerned with systems' ability to do what it was intended for, and usability focuses on how well the user can use the designed system. This thesis aims to improve both by pursuing a four step procedure outlined in abstract.

2 Research approach

The research approach in this thesis follows the classical Human Computer Interaction (HCI) practice. The thesis starts by framing research questions and hypothesise through exploratory studies and synthesis of existing knowledge. This step is followed by the design process in which solutions or test systems are being built. This enables experimentation that generates data of various types allowing researchers to confirm or reject initial hypothesis. The methodology follows a mixed research methods approach where quantitative and qualitative data types are being captured and analysed utilizing action-based and empirical research methods.

3 Results

Through the review of perceptual problems that relate to the handheld AR, within the class of table-top sized AR workspace, three usability issues were identified and confirmed through empirical user studies. In particular, results highlighting the prominence of the dual-view perceptual problem–the result of the difference between common implementation of the magic-lens, known as device-perspective rendering, and what the user would expect to see when looking though a magic-lens, which acted as a transparent glass pane [3]. Results showed that users find particular difficulty in dealing with the effect caused by the camera-screen offset e.g. the camera is not positioned in the centre of the device screen [4]. The thesis takes a design approach to the problem in which a hybrid magic-lens is proposed as one possible solution to the problem [5, 6].

Finally, by reviewing basic system utility and through design and implementation of prototypes, the research identified and confirmed three utility improvements, namely: (i) reintroduction of scale into online markerless AR systems utilizing auto-focusing feature of a camera phone [7]; (ii) improving system initialization by optimizing map initialization through sensor fusion of phone camera and other sensing capabilities, commonly available on handheld devices; and (iii) improving system utility of scene readability by enhancing rendering quality, or through an interaction paradigm that replicates a magnifying glass.

4 Discussion and future work

The main finding of this thesis is the identified prominence of the dual-view problem on usability of handheld AR interfaces. Hence, amongst others, future research should focus on different methods that will minimize the dual-view problem. One such method is a hybrid magic-lens approach which was designed and implemented within the thesis, but remains to be throughly evaluated. Additionally, future research shoulde explore how dual-view problem affects multiple user situations, particularly important as the magic-lens interaction paradigm presents information in a contextually meaningful way. Because the context is the real-world, such visualization enables intuitive context sharing amongst multiple users, making it a compelling choice for collocated multiple user collaboration.

References

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