Performative Gestures for Mobile Augmented Reality Interactio

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Abstract
Mobile Augmented Reality would benefit from a well-defined repertoire of interactions. In this paper, we present the implementation and study of a candidate repertoire, in which users make gestures with the phone to manipulate virtual objects located in the world. The repertoire is characterized by two factors: it is implementable on small devices, and it is recognizable by by-standers, increasing the opportunities for social acceptance and skill transfer between users. We arrive at the suggestion through a three-step process: a gesture-collecting pre-study, repertoire design and implementation, and a final study of the recognizability, learnability and technical performance of the implemented manipulation repertoire.

Keywords
Augmented reality, Mobile augmented reality, Gesture-based interaction

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

General Terms
Interaction, Augmented Reality, Interaction Design

Introduction

Mobile Augmented Reality is the use of augmented reality on hand-held devices, most notably mobile phones. When the idea of Mobile Augmented Reality (mobile AR) was proposed by Rohs and Gfeller [9], the authors explicitly stated a desire to use mobile AR to enhance interaction. Despite these early efforts, today's applications of mobile AR are typically restricted to fixed information overlays with little or no possibilities for interactivity. It is symptomatic that mobile AR is often described as using a 'magic lense' metaphor [6], as if pointing the device towards a marker or object will reveal its hidden, inner properties. The manipulation of those inner properties is seldom prioritized, and impoverished at best. This becomes particularly problematic for games, as these rely on players being able to manipulate the game content

We suggest a repertoire of manipulations for mobile phone AR, based on gesture interaction. Our goal is to find a repertoire that is implementable, reasonably natural and learnable, but also performative, allowing by-standers to grasp something about what users do with their devices.

Performative Interfaces

Reeves et al [7] have developed a classification of user interfaces from the perspective of a by-stander rather than the direct user. They distinguish between performative, secretive, magic and suspenseful interfaces, depending on whether by-standers can observe the interaction and/or the effects of the interaction. A performative interface is one where by-standers can observe both the action and the effect, a secretive interface is one where both the action and the effect is invisible, a magic interface one where the action is invisible but the effect observable, and finally a suspenseful interface is one where the action is visible but the effect is not.

Camera-based AR interaction on mobile phones tends to be suspenseful (as the action may be visible but the effect only is visible on the screen). However, if the interaction is implemented through well-defined and recognizable gestures, by-standers could be able to infer what the effect is. Thus, handheld mobile AR could be designed to be more performative than most alternative interaction techniques.

We believe that there are several advantages to creating performative interaction models. Performative interfaces enhance the social negotiation process as the users' current activity is (partly) visible, and the social transfer of skills is also enhanced as by-standers can (to some extent) learn by mimicking the actions of another user.

Design Study Goals

The objective of our project is to create a repertoire of manipulative gestures, where a mobile phone is used to manipulate virtual objects residing in the physical world. In designing this repertoire, we need to take several factors into account: it needs to be at least to some extent natural and learnable, but also implementable and performative.

Repertoire of manipulations

We first selected the manipulations for which to design gestures. In selecting these, we took inventory of previous AR demonstrators, to look at what kinds of manipulations they have sought to realize, as well as envisioned some applications of our own. Some of our inspirational sources have used physical manipulation of markers rather than the virtual content in order to realize interaction (see e.g. [5]); a simpler but from a usability perspective often clumsy solution, as it requires the user to at the same time hold the camera and manipulate one or several markers.

Prestudy

In order to collect possible gestures, a gesture manipulation system was simulated using an IPhone with the camera activated, a fiducial marker and a physical object in place of virtual content. Through the mobile, the participants would see the marker and the physical object. The movements of the object were simulated by a person turning and moving the physical object to illustrate the intended effect. The participants were first shown the intended effect, and then asked to think of a gesture that could cause the effect.

The physical manipulation of a physical object proved to be a good way to communicate the intended effect of gestures, and all participants were able to think of gestures for most manipulations. However, participants found it more difficult to create gestures for some of the manipulations than for others. The gestures invented for these were also more diverse.

The rotations, enlarge, shrink and picking up the virtual object are some of the most relevant results from the prestudy. Eight out of the fourteen participants invoked the rotations by flicking the mobile (clockwise or counter clockwise) around the same axis as the AR object is to be rotated. This action would start the rotation which would remain until the mobile is flicked in the opposite direction. Seven participants enlarged or shrank by pressing and holding the screen of the mobile, moving closer or farther away from the marker and releasing the screen. However, five of them got closer to the marker to enlarge and farther away to shrink while the other two to got closer to shrink and farther away from the marker to enlarge. We believed this difference is due to the lack of feedback on how the object was enlarged and shrank during the simulation done prestudy. Finally, the pick up action was mainly invoked by performing a ‘scooping up’ gesture with the phone. The difference between this solution and the others gotten in the study is that participants perform this gesture in different ways even though the concept they are trying to perform is the same.

Design of the manipulations

Based on the gesture collection study, we proceeded to design a gesture repertoire for manipulations. In doing so, we looked at technical feasibility, repertoire consistency, and lastly the choice of the majority (if there was a large difference in preferences).

Implementation

For the second study, we implemented gestures that would rotate, enlarge, and shrink the object. For enlarge and shrink we implemented the two identified variants, in order to compare them in the evaluative study. For the rotations, our primary choice was the ‘start and stop’ version described above. We also implemented a version of the movement where the object would rotate in clearly defined steps, so that a single flick would make the object move one step.

The implementation runs on a Nokia N900 with Maemo 5 as operating system. The movement recognition uses accelerometer data as well as visual information from the marker tracker. The ARToolKitPlus 2.2.0 library was used to implement a basic augmented reality application to interact with.

Evaluative study

Using the implementation, we did a second study of the gesture repertoire. In this study, the recruited participants had no previous experience or understanding of mobile AR. In this study, we first asked for the immediate interpretation of the manipulations when watched from a third person perspective, and only then handed over the phone to the participants to use by themselves.

Immediate impressions

Seven (7) of the nine participants' immediate impression was that the study organiser was using the camera or taking pictures. Three of them (aged 15-21) added that it was also possible that 'this was some kind of game', indicating that the gestures might have seemed more manipulative than ordinary camera gestures. The rotation manipulation was interpreted as a rotation, a turning, or a switching action, possibly in order to navigate through a set of options. The enlarge manipulation was interpreted as zooming with the camera (5 participants) or taking a picture (3 participants). All participants were able to identify the location of the invisible object as on or near the marker.

Usage experience

Eight out of the nine participants could perform the gestures to enlarge or shrink with a few or none instructions. The implementation of this gesture is robust and its usage fairly intuitive according to the participants. The rotations are not as robust. All of them required more instructions and practice to perform the gestures correctly.

Of the two implemented versions of enlarge and shrink, the evaluation group was as divided as in the original study: five participants preferred that the object would shrink when moving closer and four preferred the opposite. There was no clear preference concerning the continuous or the step-by-step implementation of the rotations: most users liked both solutions.

Future work

We have shown that gesture-based interaction in mobile AR applications is implementable and that it is at least partially recognizable by by-standers. As our next step, we plan to explore the function in a real application context which will be a pervasive game.

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