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The utility of Magic Lens interfaces on handheld devices for touristic map navigation

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HIGHLIGHTS

- Investigation of Magic Lens and Static Peephole on smartphones for maps.
- Two experiments: semi-controlled field experiment in a ski resort and lab study.
- For A0 sized posters Magic Lens is slower and less preferred.
- For larger workspace sizes performance between interfaces is equivalent.
- Magic Lens interaction results in better usability for large workspaces.

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ABSTRACT

This paper investigates the utility of the Magic Lens metaphor on small screen handheld devices for map navigation given state of the art computer vision tracking. We investigate both performance and user experience aspects. In contrast to previous studies a semi-controlled field experiment ($n = 18$) in a ski resort indicated significantly longer task completion times for a Magic Lens compared to a Static Peephole interface in an information browsing task. A follow-up controlled laboratory study ($n = 21$) investigated the impact of the workspace size on the performance and usability of both interfaces. We show that for small workspaces Static Peephole outperforms Magic Lens. As workspace size increases performance gets equivalent and subjective measurements indicate less demand and better usability for Magic Lens. Finally, we discuss the relevance of our findings for the application of Magic Lens interfaces for map interaction in touristic contexts.

1. Introduction

Tourists who visit cities or resorts, which they are not familiar with, often use maps as tools to orient, explore and navigate these unknown physical environments. Digital maps on handheld devices, such as smartphones, make location-based services accessible and are popular tools to support touristic needs in these contexts. The dominant technique to interact with these digital maps on devices with touch screens is Static Peephole (SP) navigation using tap-n-drag and pinch-to-zoom as used for example in Google maps. Still, physical maps continue to play an important role in the tourism sector. They address navigational needs of users if there is no data connection, but can also highlight specific points of interests

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selected by local tourism associations which might not be easily accessible through general purpose map applications like Google Maps. Furthermore, large physical maps can provide more information at a glance (i.e. a larger information space size) than small screens but lack the advantage of dynamic adaptation and personalization common in digital maps. However, in a touristic place, large physical maps might facilitate the communication between groups of friends or between family members by being a common ground for the discussion [1]. For example, if someone is pointing at a specific location on the physical map, the rest of the group can immediately be aware of the pointed location.

Mobile Augmented Reality (AR) applications have the potential to overcome both the static nature of the information on physical maps and the small screen constraints of mobile digital maps through the Magic Lens (ML) metaphor. They typically overlay digital information such as 3D models on the physical world. This information is registered with up to six degrees of freedom on physical objects such as magazines and posters and allows for the tight visual integration between the real and the virtual and for spatial navigation of the mixed space around users. Recently, ML interfaces became popular as an interface for browsing the physical world in location-based applications [2] through Augmented Reality browsers like Junaio, Wikitude or Nokia City Lens. Augmented Reality browsers typically combine an ML, an SP and a list view for geo-referenced information [3] in the vicinity of the user. Also, ML interfaces have become popular with leisure-oriented activities in gaming and advertising [4] often relying on commercially available computer vision-based tracking systems provided by companies like Metaio or Qualcomm.

However, for non-leisure activities such as information browsing and navigation on (physical) maps the benefits and drawbacks of the individual interfaces are not yet thoroughly understood. Specifically, to the best of our knowledge there are no recent studies investigating the performance of Magic Lens and Static Peephole map navigation using state of the art tracking technologies which allow for a wide interaction space and today's popular interaction methods like tap-n-drag for SP navigation. A better understanding of the potentials and pitfalls of these interaction methods, given current technology, is critical both for the designers of mobile interfaces as well as business stakeholders considering investments in the provision of novel services for tourists. Specifically, business stakeholders in the tourism domain need assessments on which user interface provides most value to users and, in turn, lead to user "click-through" as well as actual purchase or reservations. For example if ML interaction can deliver added-value in terms of performance or user experience in touristic contexts the effort of enabling ML interaction with large scale physical posters might be worthwhile. This effort consists among others of authoring 3D models, embedding video streams in a visually compelling way, and designing physical posters and maps specifically with the visual integration of disparate digital content in mind [5]. In contrast, if benefits of ML and SP interaction are comparable there is no need for added expenses and traditional location-based solutions, making small screen interaction sufficient to address the needs of tourists.

Our work therefore makes following contributions: First, we provide an up to date comparison of ML and SP navigation for a generic information browsing task on maps. We conducted a semi-controlled field experiment on a public map at the ski slopes of a tourist hotspot in the Austrian Alps. Our comparison revealed that even with state-of-the-art vision-based tracking ML is significantly slower than a conventional SP interface with tap-n-drag for a common map size in public spaces. ML also does not perform better in terms of error rate and user experience. In addition, the study did not reveal significant effects of ML interaction on the audience or an effect of the setting on the user experience rating of participants. Second, looking deeper into workspace size in a separate laboratory study, we could not see ML outperform SP, achieving at most equal performance with an increasing size of the map. But, ML significantly decreases demand and increases usability compared to SP. Third, we reflect on the implications of our findings for ML interaction in touristic scenarios.

2. Related work

ML, SP and Dynamic Peephole (DP) interaction have been studied in a variety of contexts, ranging from design space explorations [6–9], over controlled performance based evaluations [10–12] to field studies [13,1]. While SP interfaces typically move a scene behind a fixed virtual window (i.e. traditional pan and zoom using touch input) DP interfaces keep the information space fixed and move a viewing window (or virtual camera) over it (often through spatial input of users).

Several frames of references were explored for spatially aware displays (Magic Lens and Dynamic Peephole). Besides physical maps [14,5,15], VR environments [16], interactive screens [17,18] and media facades [19], physical notebooks [20], urban environments [3,21] and interaction without semantic connection to the environment [8] have been investigated. While many researchers are focusing on handheld displays like PDAs, smartphones or (to a lesser extend) tablets the rise of pico projection systems also induced a series of work about ML and DP interfaces using handheld projectors (for an introductory overview see e.g., [22]).

Controlled studies of ML, DP and SP interaction encompassed fundamental interaction tasks such as target acquisition and visual search (finding a target object among distractors) tasks and higher level tasks such as navigation. Mehra et al. compared DP and SP metaphors for line-length discrimination using a desktop PC interface with mouse input. Their results indicated that DP interfaces are superior to SP interfaces for tasks in which spatial relationships matter and display size is limited [11].

In 2008, Rohs and Oulasvirta investigated target acquisition performance with ML and DP interfaces on a handheld device [23] and formulated a two part pointing model for ML including coarse physical and fine-grained virtual pointing. They also validated their model in a real-world pointing task for varying target shapes and visual contexts [24]. Cao et al. investigated peephole pointing for dynamically revealed targets [10] using a desktop PC and graphics tablet. The authors focused on a