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Overview of Smartphone Augmented Reality Applications for Tourism

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Abstract

Invisible, attentive and adaptive technologies that provide tourists with relevant services and information anytime and anywhere may no longer be a vision from the future. The new display paradigm, stemming from the synergy of new mobile devices, context-awareness and AR, has the potential to enhance tourists' experiences and make them exceptional. However, effective and usable design is still in its infancy. In this publication we present an overview of current smartphone AR applications outlining tourism-related domain-specific design challenges. This study is part of an ongoing research project aiming at developing a better understanding of the design space for smartphone context-aware AR applications for tourists.

Keywords: Augmented Reality, eTourism, smartphone, mobile

1 Introduction

Recent advances in mobile computing, computer graphics, wireless and sensor technologies allow for the fast development of Augmented Reality (AR) applications on smartphones. A visual AR system enhances or augments the surroundings of the user with virtual information that is registered in 3D space and seems to co-exist with the real world (Azuma et al., 2001). Unlike traditional AR devices, such as head-mounted displays (HMDs) and mobile laptops, smartphones combine all necessary technologies for augmentation in one small device. This is also the first medium to introduce AR to the mass market which has enormous potential for tourism (Höllerer & Feiner, 2004; Seo et al., 2011).

In a typical GPS-based smartphone AR application for outdoor use, the user points the device towards physical objects in her surroundings. She is then able to see additional virtual information overlaid on top of the real-world camera view through virtual annotations. The type of content and amount of information within the virtual annotations varies amongst applications and can include video, images, text or symbols for different types of landmarks (Figure 1). Available data includes descriptions of tourist attractions, restaurants and monuments. Other useful information, such as WiFi spots, ATMs, car parks, transportation, local news items, and weather can also be displayed in AR-view. Several available applications allow access to geo-coded user-generated content, such as tweets, videos and photos, as well as comments and recommendations about a place.

The complex spatio-temporal behavior of tourists in unfamiliar environments requires vast amounts of information. AR-enabled smartphone applications can be used to access personalized (and private), relevant and updated information at any time and place. The main benefit is that tourists are able to view variable information about an object of interest that is placed immediately in context. However, there is still a lack of a wider adoption by the general public (Olsson & Väänänen-Vainio-Mattila, 2011) as well as tourists, many of whom prefer more traditional sources of information, such as, for example, paper-based guidebooks. The full potential of smartphone AR for Tourism is still not widely explored. Therefore, the aim of this study was to identify the key challenges that smartphone AR applications pose when used to access tourism-related information in unfamiliar environments. This study is part of an ongoing research project that examines the effective design of tourism context-aware smartphone AR applications for on-site access to geo-tagged content.

2 Criteria and Inventory

The aim of this study was achieved by conducting a review of AR applications on the smartphone market. Available commercial applications that provide AR view on smartphones were compared according to pre-defined criteria described in Table 1. The inventory in this study considered 22 smartphone AR applications. Their final selection was based on several criteria: (1) provide visual augmentation of the environment (excluding AR games and audio guides); (2) deliver content for the territory of the UK related to urban leisure experiences; (3) are available for iPhone smartphones and can be downloaded/purchased from the Apps store; and (4) use a marker-less, GPS-based approach to track, register and align virtual and physical objects.

Table 1. Selected criteria for the comparative overview and evaluation.

Functionality	Description
1. **Search and Browse**	Search and browsing (categorical search) mechanism provides access to relevant information (Rasinger et al., 2009).
3. **Context-aware push**	The tourist may miss out on important/interesting information, especially in information-rich urban settings (Raisnger et al., 2009).
4. **m-Commerce**	The possibility for booking/reservation and payment (Rasinger et al., 2009).
5. **Feedback**	A mechanism to provide and/or receive feedback from/to other tourists or tourism authorities (Rasinger et al., 2009).
6. **Routing and navigation**	The possibility to obtain directions and navigation to a POI, once it is visualized in AR view and selected (Umlauft et al., 2003).
7. **Tour generation**	Adding POIs to a (pre-generated) itinerary allows tourists to plan better and manage their leisure experience (Umlauft et al., 2003).
8. **Map services**	Helps tourists to obtain an overview of a larger territory (Suh et al., 2010).
9. **Communication**	Option to realize direct contact with accommodation providers, exhibition owners and others involved in service provision (Rasinger et al., 2009).
10. **Exploration of visible surroundings**	Apart from looking up for information about a particular item, place, object and category, tourists may wish to "explore" available information about their surroundings without pre-defined criteria (Ajanki et al., 2010).
11. **Interactive AR view**	A "clickable" AR view could serve as an interface to additional, more detailed information about a point of interest (Wither et al., 2009).
12. **Filtering of AR content**	The option to filter and change interactively the visualized content in AR view. This is an important feature, keeping in mind that urban environments are rich in potential targets for annotation (Tokusho and Feiner, 2009)

3 Potential Problems

The main aim of this study was to examine the benefits and drawbacks of smartphone AR applications when used by tourists in unfamiliar environments. The examined AR applications were classified into three main categories:

(1) AR browsers, which, similarly to web browsers, enable service and content providers to publish thematic content – Layer, junaio, Wikitude, mobeedo.

(2) Dedicated AR applications – acrossair, Augmented Reality UK, Cyclopedia, Localscope, London AR Guide, Reality 2.0, Robotvision, GeoTravel Guide, ubique, WhereMark, World Surfer, WorldViewer.

(3) AR view-enabled applications – Etips, mTrip, Tripwolf, WhereTo, Yell, Yelp.

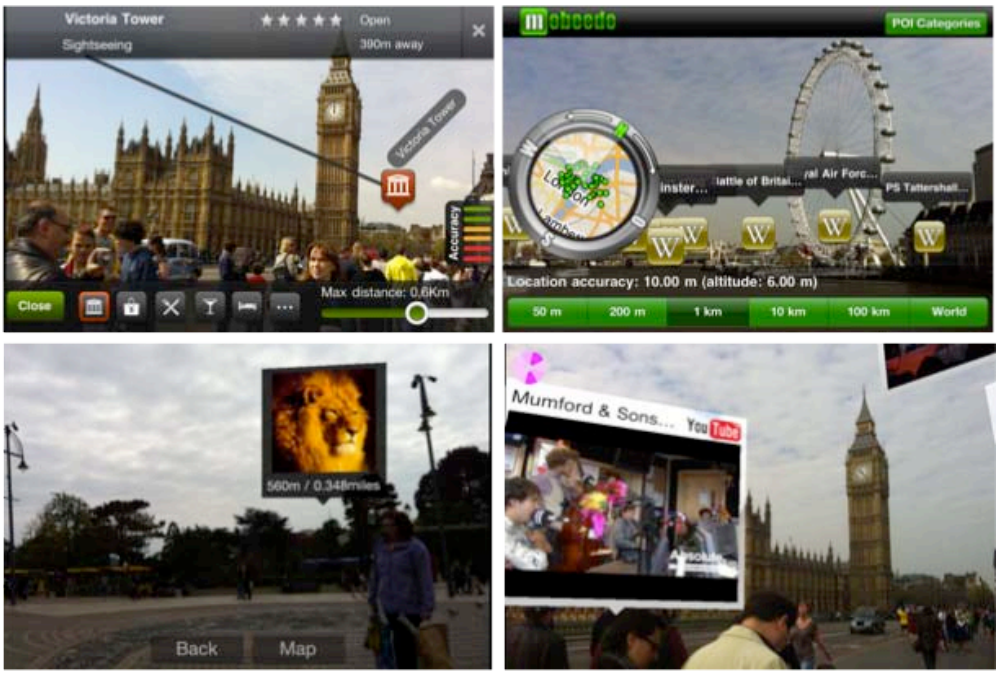

Fig. 1. AR view in commercial smartphone applications: (A) Annotation connected to sidebar, showing additional information about POI in mTrip (upper left), (B) Several POIs in mobeedo's AR view (upper right), (C) Augmented Reality UK, showing annotation about the zoo in Bournemouth (down left), and (D) Displaying YouTube video in AcrossAir (down right).

In terms of tourism-specific functionality, most applications offer interface elements for keyword *search and browse* through available information. All applications provide map-based services, even though they vary in form and implementation. However, it was observed that besides map-based services and communication, further tourism-related functionalities such as m-Commerce, feedback, routing and tour generation, are rarely supported. Context-based push of information is supported only by two applications (Yelp and mobeedo), which enable the user to set criteria for context-based notifications. Feedback is one feature that can be incorporated in AR view, enabling the user to rate and comment immediately upon his/her visible surroundings. Additionally, routing and tour generation would be suitable in AR view, since AR facilitates navigation (Takada et al., 2009).

Second, AR-specific functionality was explored (Table 1). *Exploration* of the immediate visible surroundings of the user is probably the most obvious advantage that AR mobile applications could provide to tourists. In terms of this functionality, the AR-view in the examined applications enables the tourist to either (1) display *different* virtual layers of spatially relevant information, or (2) display *one specific* virtual layer of spatially relevant information. The former approach enables the user to explore available content for an unfamiliar environment without having specific background knowledge of the most relevant/interesting content. Further, almost all of the reviewed applications provide an interactive display with "clickable" annotations that expand to deliver more information about the selected POI (Wikitude, Layar), open map view (Localscope, London AR guide) or lead to a different screen with more detailed information (mobeedo, Tripwolf, WhereMark, Cyclopedia).

One of the main problems with current AR applications is that visualization of available content in AR view without pre-defined search criteria ultimately results in an overloaded and cluttered display. This limits the legibility of information considerably (Figure 1.B). One approach to deal with this problem is by enabling the user to display only one thematic layer at a time. This functionality is supported by applications, such as Junaio, Augmented Reality UK, Localscope and Where To. Limiting the displayed content through manipulating the distance range is a particularly useful option when there is a risk of information overload. However, distance-based filtering may be confusing when object relevancy is not a mere function of distance (Julier et al., 2002).

4 Conclusion and Further Research

The main objective of this study was to explore the benefits and drawbacks of current smartphone applications in their effort to support tourists roaming in unfamiliar environments. It was found that when it comes to effective support of mobile on-site needs of tourists, current smartphone AR applications: (1) provide access to

location-based information, relevant to the immediate surroundings of tourists, (2) enable access to variable content, which is timely and updated, (3) are flexible in terms of delivering text, video, or images and (4) provide interactive annotations which are integrated with map-based services and additional information. Considering the specific nature of tourism-related applications, several problems were identified.

First, the reviewed applications do not support extensively value-adding functionalities for mobile tourism applications, such as Context-aware push of information, m-Commerce, Feedback and Routing. Second, the provided information in virtual annotations should be adjusted to suit better tourists in unfamiliar environments, providing more natural and engaging content. Ideally, context-awareness and automatic context-based filtering of content should be provided.

Implementing and developing context-aware smartphone AR for tourists is connected with undertaking a number of critical design decisions. In view of the lack of design guidelines and heuristics for mobile AR applications, several lines of investigation are worth exploring further. These include finding an effective way to implement and ensure seamless fusion of the required domain-specific functionality that supports a positive user experience; providing context-based filtering of information in AR view; adaptive visualization of content about the immediate surroundings of the user in AR view through exploring different graphical variables and visual cues. Coming up with design guidelines, principles and standards for smartphone AR applications would not only enable further adoption and proliferation of these types of applications amongst tourists, but would also facilitate the development and delivery of highly relevant mobile tourism services.

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