XRBrowser: Rethinking the Web Browsing Experience for AR/VR

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Abstract

AR and VR are becomingly increasingly widespread and ubiquitous. Using display wrappers such as Cardboard or Daydream, smartphone users now have the ability to turn their devices into see-through augmented or immersive virtual displays. In both cases the phone is the enabling platform and it can, in principle, be transformed on demand depending on a user's task, context, and preference. In my current work I investigate the new technical and design challenges inherent to such future AR/VR adaptive interfaces. Existing techniques can adapt to device aspects like form factor. But they are insufficient to detect usage of the same device for AR/VR. There is little knowledge as to which interactions are desired to trigger these use modes and what are effective adaptations to enhance the mobile user experience with AR/VR.

Author Keywords

augmented reality; virtual reality; cross-device interfaces.

ACM Classification Keywords

H.5.2 [User Interfaces]: Input devices and strategies

Motivation

We live in a rapidly evolving landscape of interactive computing devices with many different capabilities, not only in terms of form factor, but also use modalities.

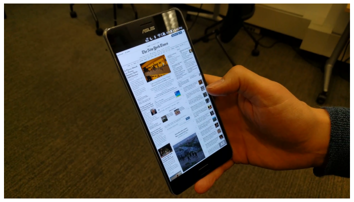

Figure 1: Use default mobile view

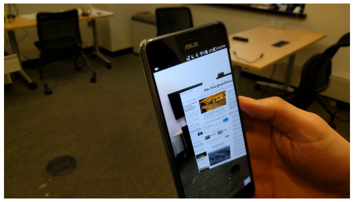

Figure 2: Switch to mobile AR view

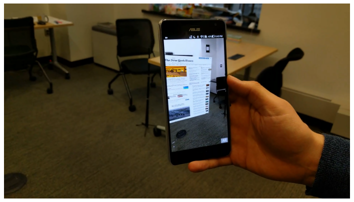

Figure 3: Use mobile AR view

In particular, there is an increased proliferation of AR/VR devices that are becoming increasingly widespread and ubiquitous. Oculus Rift and HTC Vive are examples of virtual reality headsets (which provide realistic images, sounds and other sensations that simulate a user's physical presence in a virtual or imaginary environment). On the other hand, Google Tango and Microsoft HoloLens provide see-through and heads-up augmented reality displays (which, as a step before fully immersive VR, provides a composite view that superimposes computer generated images on a user's real-world view).

Previously, AR and VR interfaces were easy to separate technologically as they had to be developed on different platforms. The recent introduction of technologies like Google ARCore and Daydream, however, makes it possible to build on the latest generation of smartphones as a common platform, essentially turning smartphones into fully capable AR or VR devices. To obtain an AR view, a device only needs to activate the rear camera and render a "magic window" via 3D perspectives on digital content. Alternatively, display holders like Google Daydream or Samsung Gear VR can instead transform the same device into a completely virtual heads-up display.

In my current research, I am particularly intrigued by the important role that smartphones play in these new kinds of phone-based AR/VR interfaces, and how this is likely going to impact the way we design more adaptive interfaces. Despite this transformation ability, there is relatively little work that addresses the challenges of developing future interfaces that will support a profusion of AR/VR-capable devices. Yet, there are many interesting issues to be studied. The discussion is often guided by technical and also many practical issues, such as the fractured ecosystem of vendors, to support seamless transition to AR/VR experiences. There are, however, also significant issues on the user interface design side.

In this position paper, I will try to uncover some of the technical and design issues associated with bridging AR and VR display settings. I will do so by first describing a new research prototype called *XRBrowser* that I have started to work on in my lab — *XR* to indicate that we aim to support web browsing experiences that seamlessly transition from traditional mobile settings to AR and VR. This work draws from earlier research on user interface patterns and user-desired interactions around a new "multi-browsing system" [2] called *XDBrowser* [4, 5] — *XD* to emphasize my previous focus on cross-device interface research. Now, with XRBrowser, I have started to make cross-device interfaces the foundation for some of my new work, and have shifted my focus to thinking about how AR/VR provides new opportunities for cross-device interaction design. I hope to convince readers of my position that we will have to adapt, if not completely rethink, existing web and mobile interface design and development approaches to enable this transformation.

XRBrowser Prototype

XRBrowser is a new web browsing system I have started to develop to explore how to best enable transitioning from traditional mobile browsing experiences to AR/VR. Much of the interaction in AR/VR is different from what today's mobile users are familiar with. Rather than touch, there is heavy emphasis on using cameras and motion as the new input. Many new implicit types of interaction with AR/VR content are enabled simply by physically moving the device and target physical/digital objects to trigger actions. This in turn raises a number of usability, accessibility, and privacy issues, both for users and non-users of AR/VR devices, in need of investigation.

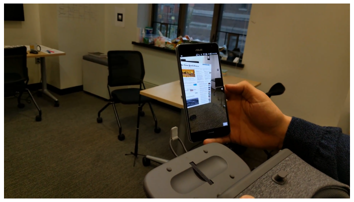

Figure 4: Use mobile display holder (here Daydream)

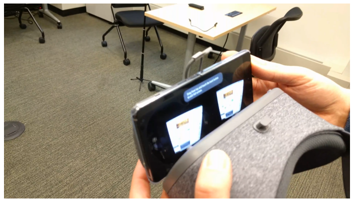

Figure 5: Switch to mobile VR view

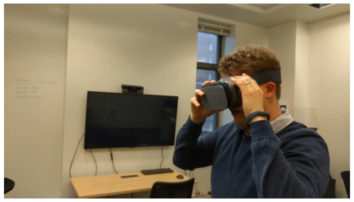

Figure 6: Use mobile VR view

To better understand the technical and design requirements for adaptation to AR/VR, I developed a preliminary prototype called *XRBrowser*. As illustrated in Figures 1 to 6, XRBrowser is a new mobile browser interface allowing users to switch from a standard 2D view of a web interface, which is the default, to a 3D AR view that reacts to physical device movement and camera input in the user's environment, to a 3D VR view that turns the user's display into one that is split into two, giving the illusion of depth (an off-axis stereoscopic effect) for an immersive VR experience when placed in a Google Cardboard-like display holder, here Daydream.[1]

For this concept to work, the technical requirements include *(R1)* **techniques to detect device usage as AR/VR display** (detection of device motion, orientation, environmental light, etc.); *(R2)* **techniques to adapt the web browser interface to AR/VR device usage** (e.g., new browser interface optimized for see-through AR or heads-up VR display using gestures and controller input); *(R3)* **techniques to specify adaptation of web page content and interaction to AR/VR** (e.g., extensions of HTML/CSS to lay out 2D content in 3D and respond to gesture and controller input in addition to touch events). On the other hand, the design requirements include *(R4)* **knowledge of the contexts and situations in which users are likely to use AR/VR adapted views** (e.g., standard mobile display usage on the go, AR display usage in the office, VR display usage in the living room at home); *(R5)* **knowledge of desired user interactions to transition between 2D mobile and 3D AR/VR views** (browser menus, buttons, gestures, etc.); *(R6)* **knowledge of what types of web content and how each needs to be adapted for AR/VR** (e.g., rendering menus as 2D overlays, main content as "magic window" anchored in 3D space and superimposing the real-world view).

This early prototype of XRBrowser helped me develop a first sense of how to best approach the design and the issues that need to be addressed to bridge traditional mobile and AR/VR experiences. Next, I want to reflect on this research so far and discuss what I think will need to happen moving forward with this and similar projects.

Reflection and Future Work

This research adds to the native mobile vs. web debate [1] and explores the potential of the web as a device-agnostic platform to power AR/VR interfaces. The proposed research pushes my previous work on multi-device touch and gesture-based interfaces [6, 7] to cater to the wide range of new AR/VR devices. In his most recent work on XDBrowser [4, 5], I have explored how to best extend current web browsers to support the design of *cross-device interfaces* that can adapt and distribute interfaces between many mobile devices such as smartwatches, phones, and tablets.

The proposed research adds to this growing body of cross-device research in two ways. First, it generates new knowledge in interface design based on user studies around AR/VR interfaces where so far only few design guidelines exist [3]. In particular, better understanding the unique affordances of hand-held *vs.* head-worn AR/VR interfaces, and how users could easily transition between these interface modes for different contexts and tasks will drive future AR/VR development. Second, it develops a set of concepts and techniques that will enable web developers to more easily specify and support increasingly complex AR/VR content and behavior depending on the types of devices and how they are being used.

[1] A video of this prototype is available at https://vimeo.com/242573100.

Significance for Workshop

The main outcome of this research will be innovative approaches to making interface design more flexible by enabling adaptation for a range traditional mobile as well as AR/VR devices. I hope to join the CHI workshop on rethinking interaction. I would like to contribute with my experience and knowledge of conducting systems research around novel kinds of interactive systems, where XDBrowser and the new XRBrowser are just two examples. I envision new forms of responsive design and progressive enhancement that adapt both mobile input and output to AR/VR devices. I feel like with the current approaches to AR/VR—native, cross-platform using Unity, and web-based—we have essentially repeated the fragmentation problem we already have with existing mobile development approaches. While native Android and iOS solutions are likely to yield the best results for ARCore and ARKit, there are new promising efforts such as Mozilla's WebXR to drive standardization and move towards adaptive AR/VR design. In particular, future web and mobile applications will need to provide multiple layers of information and interaction to support transition from traditional mobile to AR/VR. To facilitate this, new methods to create such adaptive interfaces as well as user studies around AR/VR device usage for a variety of interfaces and tasks will be required. In a first wave, I would expect a range of new AR/VR elicitation studies to generate user-defined interactions similar to recent work by Piumsomboon et al. [8]. I would hope, however, that the HCI community then also follows up with systems research that implements these proposals and investigates their usefulness as well as feasibility in more detail. This is where I hope my work with XDBrowser, first to find interface patterns [5] and then methods to support automation [4], can inspire research along this direction.

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