XR Accessibility – Learning from the Past and Addressing Real User Needs for Inclusive Immersive Environments

Introduction to the Special Thematic Session

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Abstract. XR is an acronym used to refer to the spectrum of hardware, software applications, and techniques used for virtual reality or immersive environments, augmented or mixed reality and other related technologies. The special thematic session on ‘XR Accessibility’ explores current research and development as well as presenting diverse approaches to meeting real user needs in immersive environments. The contributed research papers range from using spatial sound for object location and interaction for blind users, to alternative symbolic representation of information, Augmented Reality (AR) used in rehabilitation for stroke patients and vocational skills training for students with intellectual disabilities. The session also explores what we can learn from previous research into immersive environments – looks at opportunities for future research and collectively explores how we can together iterate accessibility standards.

Keywords: Accessibility · Virtual reality · Augmented Reality · Immersive web · Rehabilitation · Serious games · Inclusive design · Usability

1 Introduction

The discipline of web accessibility can now be considered to some degree ‘traditional’. There are established conventions that are used or considered part of best practice to support accessible design and development. Whether it is users needing to access simple structured text and information via webpages, consume rich media and its alternatives or interact with more complex dynamic web applications in a way that works with complex assistive technologies like screen readers - there is now greater understanding of what these diverse user needs are, as well as what is required to support those needs and how a designer or developer may make this content more accessible to people with disabilities.

There is certainly more work to do, via awareness raising and advocacy required from disability groups, standards bodies and so on but we can say a solid foundation
has been laid by the combined hard work and dedication of those actively involved and engaged in removing barriers for people with disabilities.

Simple practices like adding text alternatives, structuring page content using appropriate semantics, correctly labelling form inputs and controls have all become core skills and part of best practice for the accessibility aware designer and developer.

However, the technical landscape is forever in flux and while the needs of people with disabilities may arguably be considered a constant in relation to these changes the dynamic nature of technology demands consistent attention and is ever presenting new challenges that need to be addressed.

2 The Relevance of XR for Accessibility

XR presents many opportunities and challenges to the ‘traditional’ model and practices of accessible web design and development. In some cases it extends it, in that current best practices can be applied or extended in new or novel ways but in other instances may confound it.

This is largely because as distinct from traditional web content, in practice, very little is understood about the needs of people with disabilities within immersive environments.

To further compound this problem there are assumptions that can be made on the basis of previous knowledge and experience in 2D web that may not always be helpful in XR. XR presents a new advanced model, with inherent opportunities and challenges for the user and designer/developer alike. We need to both identify and distinguish areas where current practices of traditional design and development are useful, from where they need to be rethought.

It is then important to be able to iterate abstractions such as applicable principles to practical requirements in a way that meets real user needs, in order to both challenge the assumptions of a priori knowledge in this area, as well as ask new questions.

This process will help us build on the acquired collective knowledge that is reflected in world leading accessibility standards like WCAG [1].

2.1 Lessons Learned and Building on Previous Research

We have an advantage in meeting any new technical challenge in emerging technology if we take care to not ignore previous legacy research in new XR accessibility initiatives. As mentioned, it is arguable that the needs of people with disabilities do not change very much, only the technology changes.

Understanding this as a principle can lead to solid practical approaches to addressing new technical challenges. Not understanding this as a principle can lead to tokenism, or poorly implemented solutions that do not meet real user needs.

If we adopt this view, we can build on meeting these needs iteratively. There is current work going on in this space at the W3C Web Accessibility Initiative (WAI) for example on ‘XR Accessibility User Requirements’ that aims to inform the reader of practical user needs and potential requirements that should be addressed in XR environments. It outlines the complexity of understanding XR, introduces some
accessibility challenges, accessibility multimodal support for a range of input and output devices, and the importance of customisation and personalisation.

It then outlines accessibility user needs for XR and their related requirements, followed by information about related work that may be helpful to understand the complex technical architecture and processes behind how XR environments are built and what may form the basis of a robust accessibility architecture for XR [2].

2.2 XR Research - the Benefits of Co-design and Usability Testing

XR is an exciting and challenging space to work in and many of the papers presented in this session demonstrate the benefits of co-design and including users in research and development work [5, 6].

Primarily it is important to gain a clear understanding of diverse user needs in this space. This can be done by conducting usability testing under an experienced user test facilitator or building platforms with active input from users who have diverse needs. These methods and interactions with real users will help give deeper designers and developers a rich insight that will inform better design and development decisions.

Once you have a clear understanding of diverse user needs, practical requirements can follow to meet these needs. Without that broad understanding it is hard to have a clear vision of what these requirements should be, as they may be developed with only a mere hazy idea of what they may be.

Good accessibility practices can also leverage the nexus between various cohort requirements – and expert experienced usability test facilitation can spot where there may be competing needs between the requirements of one group and another and not suggest user interface changes that benefit one cohort over another.

This will be a potentially greater challenge in XR accessibility and also illustrates the need for personalization, customization and so on that is fit for purpose to address conflicting cohort user needs. This is something that is not discussed much in the accessibility community but may become more prominent in addressing accessibility user needs in emerging technologies like XR.

Ultimately, we can learn much from these inclusive design processes, facilitate better social inclusion, build personalised abstractions of immersive environments that are interoperable and fit a person’s particular ability and need, without contradicting any other set of needs.

The ability to personalise an XR user environment gives broad scope and potential to true bespoke XR that is inclusive. Abstractions like this can be built on strong semantics, interoperability with various device APIs and assistive technologies [3].

3 Uniting Multi-disciplinary Approaches

XR accessibility is being explored in these papers via multi-disciplinary approaches, which are critical for the successful amalgamating of UX, serious games, the creation of new semantic architectures, better accessibility standards, XR software development and an inclusive immersive web.
Many who are skilled in inclusive design come from diverse backgrounds and leverage these broad range of skills in unforeseen ways. Unique perspectives and the unification of collective creative thinking with inclusive design methodologies help to facilitate better technologies and imaginative solutions.

There is then potential for work on XR accessibility to promote the social model of disability - via the broader adoption of the outcomes of this research. Mainstreaming of innovation originally from the disability space may bring XR related assistive technologies to the masses via ubiquitous devices, such as what currently happens with the sort of sophisticated assistive technology already embedded in widely available iOS or Android devices or indeed any other future platforms that will be broadly commercially available.

Regarding valuable progression of the social model, the mainstreaming of this work is also a chance to reframe the technological discussion around the spectrum of different types of disabilities to better accept the user and their inherent ability as they are, and continue to explore the options around use of any given technology to better support that ability.

A further opportunity is to identify that ability and look at intelligently supporting functional need in the context of that user’s ability.

4 Challenges in XR

There are challenges for assistive technology users in XR and ensuring ease of use and better interoperability within immersive environments. This can be as a result of complexity when using various input devices simultaneously, or the need for a high degree of precision coupled with timing accuracy and simultaneous action or by requiring tricky gestures to complete a task.

While some of these issues can be mitigated by the careful customisation of an assistive technology setup for the user, or remapping gestures to simpler patterns - there are other challenges around legacy support for older assistive technologies and how interactions can be mapped in XR to existing user setups.

There are other more generic issues with motion sickness and sensory conflict that are common with many users of XR but these may be even more severe for people with disabilities.

Other technical challenges include the need for an architecture that inherently supports accessibility. This may be modular and involve the combined development of advanced semantics, designed to describe specific parts of the immersive eco-system - relationships between objects, persons, places things their state and so on.

In immersive environments it is imperative that the user can understand – within the context of their mode of choice - what objects are, understand their purpose, as well as another qualities and properties. These include interaction affordance, size, form, shape, relational information and other inherent properties or attributes such as even an object’s fragrance in order to create advanced multi modal systems.
4.1 Integrating XR Technologies for Young People with Cognitive Issues

There are other challenges in terms of integrating these technologies for young people with cognitive impairments to help them understand what parts of XR they can use and what can be helpful to them.

Co-design of interfaces and applications involving users with cognitive impairments could be very helpful so the affordances that are available to the user are commonly expressed and understood.

A challenge is that the perceived value of an XR system may not be immediate - the user may not understand the technology - or the features that will help them.

Getting this right reduces the potential for pressed a ‘wrong fit technology’ upon a user and ensuring technologies are not developed without clear understanding of user needs.

Gaining acceptance of these technologies is still an issue and we do not want to reproduce the issue of ‘device abandonment’ in the XR space [4].

5 Discussion and Conclusion

We have seen how accessibility features may lead to mainstream innovation for the majority population, voice commands for example are now widely used. We believe this will likely also be the case for XR; in fact, some papers here already seem to indicate the potential for such mainstream innovation.

All the papers presented and represented in this session indicate both valuable current work in an exciting emergent field, as well as laying the groundwork for future research.

They also reflect the importance of a multi-disciplinary approach that must gather all the various threads that make up emerging accessible technologies and architectures, whether in the browser or via other devices.

These papers reflect the existence of current vibrant inclusive design practices and the value inherent in clearly understanding diverse user needs and then ensuring related requirements both come from and meet those needs.

Finally, any future accessibility standards that are going to successfully address emergent technologies will need to be built upon substantial understanding of these diverse user needs. The research that we present in this special thematic session are examples of crucial contributions to this understanding.

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