Remote XR Studies: Exploring Three Key Challenges of Remote XR Experimentation

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ABSTRACT

HCI and social science experimentation that explores or uses extended reality (XR) has been particularly impacted by the recent Covid-19 pandemic. This is due to typical deployment of XR experiments inside laboratories, and a paucity of research into how to effectively conduct remote XR experimentation. This first CHI Remote XR workshop aims to explore the current state of the art around three main themes of remote XR experimentation: (i) participant recruitment and screening; (ii) data collection, including limitations and affordances of existing research and XR tools; and (iii) software frameworks and requirements for the effective design of encapsulated remote XR user studies. This workshop brings together researchers and practitioners in XR to explore these recently emerged themes and to imagine how effective future remote XR research might be conducted.

CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality**; **Virtual reality**.

KEYWORDS

Extended Reality, Virtual Reality, Augmented Reality, expert interviews

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1 BACKGROUND

Extended reality (XR) technology - such as virtual, augmented, and mixed reality - is increasingly being examined and utilised by researchers in the HCI and other research communities due to its potential for creative, social and psychological experiments [1]. Many of these studies take place in laboratories with a co-present researcher and participant [4]. The XR research community has been slow to embrace recruiting remote participants to take part in studies running outside of laboratories - a technique which has proven useful for non-XR HCI, social and psychological research [9][8]. However, the current Covid-19 pandemic has highlighted the importance and perhaps necessity of understanding and deploying remote recruitment methods within XR research.

In our previous research (submitted to CHI, current review score 4.25), we collected data from XR researchers regarding their experiences and thoughts on remote XR user studies. Through thematic analysis, we outlined three major themes that could benefit from further discussion: participant recruitment and screening; data collection, including limitations and affordances of existing research and XR tools; and the future of "encapsulated" experiments as an ideal for remote XR research. By encapsulated, we refer to experiments in which the data collection and experience are combined inside a singular application, provided to participants for an unsupervised session.

In this online remote workshop, we will engage with a community of XR researchers and practitioners, focusing on practical aspects that could be developed to aid remote XR research. These include creating guidelines for participant pre-screening; ideas for remote XR participant recruitment; establishing requirements for frameworks for remote data collection; and discussing challenges and potentials for encapsulated studies.

2 WORKSHOP THEMES

We propose three main themes for the workshop. They will be addressed in three sessions (detailed in Table 1 below).

2.1 Theme 1: Participants: who are they, are they representative, and how do we access them?

The recruitment of online participants for non-XR experiments is generally considered effective [3], and often happens through

platforms such as Amazon Mechanical Turk [6]. While this approach has been used for XR studies [5], the use of XR-specific hardware has limited the participant pool (e.g. only 1.4% of Amazon Mechanical Turk respondents have access to head-mounted VR displays [7]). Participants also may have to have access to a dedicated physical space (e.g. devices usually require an empty 2x2 metres, while AR experiments may need fixed locations), as well as other common experimental requirements (e.g. no distractions) [7].

This limited participant pool raises two questions: is it representative of wider populations, and how do we effectively access this smaller pool of users? To answer this, we need a better idea of who these users are and how to target them.

In additional, it is important to understand ethical concerns of using participants in different countries and within different cultural/social/physical environments.

2.2 Data collection: identifying drawbacks of remote XR and advantages from the data collection affordances built-in to XR hardware

Laboratory settings allow researchers to setup and capture many different types of data from a participant, which have previously not been practical for remote XR studies (e.g. physiological data, external cameras, bespoke hardware interactions). It is reasonable to suggest that remote XR experiments are not yet able to easily recreate this level of data collection.

However, modern XR-enabling hardware (such as consumer VR kits) allow for many types of data collection that was previously difficult to collect or required bespoke setups. Different variations of XR-hardware also enable further data collection (such as HMDs with in-built eye-tracking). There are also novel approaches to understanding human activity that are possible via XR-hardware that have previously used dedicated sensors, such as using microphones to measure exercise exertion or body [10] or head movements [11] for focus on interest and interactional attention.

We believe it is important for the XR research community to outline both the limitations and potential of existing XR-hardware, as well as imagine what an idealised XR-hardware-as-data-collection device might look like.

2.3 Encapsulated studies: how can we lower the barriers to creating encapsulated experiment software, to maximise the potential of remote XR research

Software applications for XR development have been traditionally developed with the assumption of lab-based experimentation. Work is being done to simplify the data collection step for XR experiments built in Unity [2].

However, there is not yet an approach that is dedicated to the requirements of remote studies. In fact, we still need to establish the requirements for the development of a software framework that allows the effective implementation of remote XR studies.

This should not only include the data collection methods, but also libraries to transfer and store the data safely and easy-to-setup environments to run studies. This type of "encapsulated experiment" could also improve replication and transparency, as theorised by Blascovich[1], and allow for versioning of experiments, in which researchers can build on perfect replicas of other's experimental environments and processes. Questions remain over what are the constant features that should be at the core of most XR remote research and that should necessarily be present and available for researches who want to deploy a remote XR user study.

3 WORKSHOP AIMS AND OUTCOMES

This workshop invites contributions from researchers and practitioners working in diverse settings and using a range of XR devices and applications. The workshop aims to:

- Provide a forum for researchers to share experiences of remote XR research
- Identify common issues researchers have faced and discuss how these have or can be addressed
- Identify unresolved challenges and gaps in the field
- Produce guidelines for the development of participant recruitment processes
- Discuss data collection affordances, and the features of a research-oriented VR hardware setup that allows for broader XR research to be carried out remotely
- Produce guidelines for software frameworks and applications that allow XR research to be carried out through encapsulated remote user studies

The workshop will provide opportunities for researchers to learn from each other and to develop practical strategies to overcome the existing limitations of remote user studies in XR. These themes will be communicated to the XR and HCI community through a handbook of guidelines for the design of recruitment processes, and software and hardware for remote XR research.

4 ORGANIZERS

Francesco Soave is a PhD candidate of the EPSRC+AHRC Media and Arts Technology Centre for Doctoral Training at Queen Mary University of London. Soave's research explores motion perception in Virtual Reality, haptic feedback, presence and cross-modal interaction. He is Chair of the Queen Mary Immersive Experiences Working Group whose activities include seminars and workshop on XR practices.

Jack Ratcliffe is a PhD candidate of the EPSRC+AHRC Media and Arts Technology Centre for Doctoral Training at Queen Mary University of London. Jack's research explores embodied cognition in Virtual Reality. He is Chair of the XR Distributed Research Network (XRDRN.org), a platform for publicising remote research experiments.

Melynda Hoover is currently pursing her PhD in Human Computer Interaction at Iowa State University where she works at the Virtual Reality Applications Center. Her dissertation research focuses on integrating adaptive systems with VR training to improve the user experience. Recently, she has been exploring techniques for facilitating remote, unmoderated VR research. Her previous work includes studying augmented reality for manufacturing and assembly applications and user experience research for training

and simulation design.

Francisco R. Ortega is an Assistant Professor at Colorado State University and Director of the natural user interaction lab (NUILAB). Dr. Ortega earned his Ph.D. in Computer Science (CS) in the field of Human-Computer Interaction (HCI) and 3D User Interfaces (3DUI) from Florida International University (FIU). He also held a position of Post-Doc and Visiting Assistant Professor at FIU between February 2015 to July 2018. Broadly speaking, his research has focused on multimodal and unimodal interaction (gesture centric), which includes gesture recognition and elicitation (e.g., a form of participatory design). His main research area focuses on improving user interaction by (a) multimodal elicitation, and (b) developing interactive techniques. The primary domains for interaction include immersive analytics, assembly, and collaborative environments using augmented reality headsets. His research has resulted on over 76 peer-reviewed publications including journals, conferences, workshops, and magazine articles, among others, in venues such as IEEE TVCG, ACM PACMHCI, ACM ISS, ACM SUI, and IEEE 3DUI, among others. He is the first author of Interaction Design for 3D User Interfaces: The World of Modern Input Devices for Research, Applications, and Game Development book by CRC Press.

Nick Bryan-Kinns is a Professor in Interaction Design and Director of the EPSRC+AHRC Media and Arts Technology Centre for Doctoral Training at Queen Mary University of London (QMUL). Bryan-Kinns is a Fellow of the Royal Society of Arts, and leads the Sonic Interaction Design Lab in the Centre for Digital Music. Bryan-Kinns' SID research explores participatory design, collaboration, mutual engagement, interactive art, cross-modal interaction, and tangible interfaces. Bryan-Kinns' activity also includes running workshops at HCI and SID conferences and events such as ACM CHI (2016,2017,2018, 2019)

Laurissa Tokarchuk is a Senior Lecturer in the Cognitive Science and Game AI groups at the School of Electronic Engineering and Computer Science at Queen Mary University of London (QMUL). Her primary research interests are in XR HCI, Data driven methods for HCI, Mobile and Location-Based Gaming, Mobile Sensing, Social Computing, Social Sensing, Recommendation and Game AI. Tokarchuk previously organised workshops at conferences include Sensys-ML 2019 and ACM UbiComp (2016, 2013).

Ildar Farkhatdinov is a Lecturer in Robotics at the School of Electrical Engineering and Computer Science at Queen Mary University of London (QMUL) and an Honorary Lecturer at the Department of Bioengineering of Imperial College London. His primary research interests are in the field of human-robot/computer interaction, in particular, haptics, teleoperation, human sensory-motor system, as well as in design and control of robotic systems. He currently works on human balance control and its implementation for lower limb exoskeletons.

5 PRE-WORKSHOP PLANS

A call for participation will be launched, inviting position papers for review, in addition to the three themes proposed: i) participant recruitment for remote XR research, ii) data collection and affordances of research-oriented XR hardware devices, iii) encapsulated design and development for remote XR research applications.

The call for participants will be sent to SIGCHI email list, design list and VR list. In addition, we expect submissions from practitioners from industry with XR professional background.

The workshop organisers will review the short papers to select up to a maximum of 20 participants for the workshop. Selected papers will be shared through the workshop website with participants before the workshop to facilitate pre-workshop synthesis across papers.

6 WORKSHOP STRUCTURE

The workshop is designed to provide an opportunity for researchers to discuss the needs and limitations of remote XR practice. The aim, broadly, is to collaboratively imagine practical futures for idealised remote XR research processes, and outline the requirements to reach these.

The workshop will take place in an online environment as a virtual activity during the conference. The structure of the workshop is summarised in Table 1, and consists of three sessions, one for each theme outlined above: participant recruitment, XR hardware and data collection, and encapsulated experiments.

Each of the first two sessions consist of two sprints: the first for discussing relevant prevalent challenges, and the second for imagining ways to overcome these. In each sprint, participants will be split into two breakout rooms to allow for more intimate, involved discussions. At the end of a sprint, the groups will reconvene to share results (as shown in Table 2). The third session is an open discussion, partially based on learnings from the first two, and leveraging a cooperative shared annotation space for sharing and arranging ideas.

We are currently testing different methods to host the workshop in an online virtual space (i.e. Mozilla Hubs). If this was not possible, the workshop will take place in a normal video conferencing application and additional platforms will be used for the interactive activities (e.g. Miro, Mural or Google slides).

The total duration of the workshop, including breaks, will be 3.5 hours.

Sessions 1 and 2 are structured as described in Table 2.

7 POST-WORKSHOP PLANS

Our aim for the workshop is to collect the needs and limitations of current XR research practices and to imagine how the future research in this field could be. With the information collected during the workshop we will:

- Circulate notes created in the workshop with participants.
- Propose guidelines for the design of future research-oriented XR hardware, software frameworks and deployment platforms for remote XR user studies.
- Prepare a journal paper on the themes of the workshop.

8 250-WORD CALL FOR PARTICIPATION

Call for Participation: Remote XR Research Workshop at CHI 2021

Table 1: Workshop Structure

Activity	Time (minutes)	Description
Welcome	10	Workshop introduction
Session 1	45	Discuss remote participant recruitment and the prototyping of a dedicated platform or processes
Coffee Break	15	-
Session 2	45	Discuss the needs and limitations for remote XR data collection, and affordances of XR hardware devices
Lunch Break	30	-
Session 3	45	Discuss software frameworks to be used by researchers for encapsulated remote XR experimentation
Conclusion	10	Summary

Table 2: Session Structure

Part	Time (minutes)	Activity
P1	5	Joint Introduction
P2	15	Breakout discussions
P3	5	Joint presentation of P2 outcomes
P4	15	Breakout discussions
P5	5	Joint presentation of P4 outcomes

Research experiments in the XR/MR/VR field has traditionally taken place in dedicated space and laboratories and been supervised by the researcher. With COVID-19, the sudden transition to remote experimentation has left many researchers without opportunities to carry on their user studies. This is partially due to the lack of remote-oriented solutions for XR research.

This workshop will bring together researchers and practitioners in XR research with the goals to:

- Reflect on the limitations of current participant recruitment for remote XR studies, and the requirements for effective on-going recruitment
- Identify the characteristics of existing XR research and explore the opportunities XR hardware brings to remote experimentation, as well as what other features might be implemented with a "research-oriented" approach
- Discuss the needs of a standardized software framework to conduct encapsulated remote XR experimentation and the benefits it might bring

Participants should submit position papers (max 3 pages in CHI Extended Abstract format) about their XR research and practice addressing the themes listed at the workshop website. Position paper submission is to the workshop website. Participants will be selected based on the quality of XR research and practice and with a view to creating a balance of topics in the workshop.

Please note that at least one author of each accepted position paper must attend the workshop and that all participants must register for both the workshop and for at least one day of the CHI 2021 conference.

Important information: • Website: http://www.mat.qmul.ac.uk/xr-chi-2021/ • Position paper submissions due: (on or before) 21 February 2021. • Participants notified of acceptance: (on or before) 1 March 2021. • Workshop days: Saturday, 15 May 2021.

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