Remote XR Studies

Remote XR Studies: The Golden Future of HCI Research?

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ABSTRACT

While extended reality (XR) research usually takes place in a controlled lab setting, the COVID-19 pandemic has forced many researchers to move their research out of the lab and conduct so called "Remote XR Research". Our position for the workshop is two-fold: First, there is a need to define what the term "Remote XR Research" means and identify the key challenges in validating remote XR research as a methodology. This enables researchers to understand the advantages (e.g., better representation of demographics, remote in-situ experiments) and the potential pitfalls of this research method for HCI research. Second, remote XR research (however it is defined) can be particularly helpful in situations where researchers aim to study real-world systems or user behaviour that are usually challenging to study or require a significant amount of effort and resources. Remote XR studies can and should, if the research question(s) and research aim(s) allow it, be applied to different fields of human-centred research, especially during times where face-to-face user studies are prohibited.

CCS CONCEPTS

• **Human-centered computing → HCI design and evaluation methods**; **Mixed / augmented reality**.

KEYWORDS

Virtual Reality, Augmented Reality, HCI, Remote Studies

ACM Reference Format:
Florian Mathis, Xuesong Zhang, Joseph O'Hagan, Daniel Medeiros, Pejman Saeghe, Mark McGill, Stephen Brewster, and Mohamed Khamis. 2021. Remote XR Studies: The Golden Future of HCI Research?. In *CHI Conference on Human Factors in Computing Systems (CHI '21), May 8–13, 2021, Yokohama, Japan.* ACM, New York, NY, USA, 3 pages.

CHI '21, May 8–13, 2021, Yokohama, Japan

1 HCI RESEARCH: STATUS QUO

Human-computer Interaction (HCI) researchers have applied many different research methodologies in the past, ranging from traditional lab-based studies to more newfangled studies (e.g., remote VR studies on social VR platforms [15]). While lab studies are still the most leveraged study type in HCI, an analysis by Lisa Koeman [5, 6] indicated the number of studies which occurred in the lab decreased from CHI 2018 to CHI 2020 (2018: 47.5%; 2020: 42.5%) while other research methodologies were used more frequently (e.g., usage of remote studies increased from 10.5% in 2018 to 15.2% in 2020) [5, 6]. More *"traditional"* remote HCI research methods such as online surveys or remote interviews are already well respected and widely used in different research fields (e.g., security/privacy research [1, 14] or even for HCI meta-analyses [19]). It is also important to note that the HCI community seems to have a common understanding of what constitutes a lab study vs what constitutes a field study (which is not necessarily the case in the context of "Remote XR Research" [13]).

Besides "traditional" VR user studies, researchers have started to use VR as a test-bed to conduct non-VR based HCI research and discussed how VR as a test-bed can further be used to run human-centred remote user studies [7, 8]. In a similar vein as how online surveys are leveraged by researchers to get to scale, remote XR studies can open the door for further research that can inspire and augment existing HCI research methodologies. However, before we can treat "Remote XR Research" as a fundamental and valid research method it is important to define the term itself and identify the "grand challenges".

2 WHAT IS "REMOTE XR RESEARCH"?

The beginning of wisdom is the definition of terms, so said the philosopher. We argue there is a need to define common terminology and methodologies for remote XR research to take advantage of the methodology, and for remote XR research to see wide-scale adoption. The earlier this can be achieved, the better studies of this type can be conducted (from the perspective of authors) and evaluated (from the perspective of reviewers). However defining such terms is challenging and will likely require community efforts and a

range of stakeholder inputs (e.g., see [13, 16]). It can be particularly beneficial for individual researchers but also for the community as a whole to find answers to following questions: Which XR studies conducted remotely can be considered "Remote XR studies"? Does the term "Remote XR study" require participants to wear a VR/AR headset? Or is a study that prepared material and then deployed the VR-video material online (e.g., [8]) also considered to be a remote XR study? Without a clear definition, people have different expectations. From the perspective of an author, a clear definition helps to better position the work in the existing literature and enables comparisons between the conducted work and already published works. On the other side of the story, making it clear what has been done and also how it has been done can support reviewers to more easily grasp the value, assess the validity, and see the contribution of the work. Initial steps have already been taken towards this, as Steed et al. [17] have already emphasised the importance of considering how we move XR research out of the lab and how we can make reviewers aware of the changing nature of research.

3 THE BREADTH OF "REMOTE XR RESEARCH"

Extending upon the work by Suh et al. [18], which argues that XR experiments can broadly be categorised into two groups, we argue remote XR research can broadly be categorised in (at least) two main applications for HCI research.

3.1 Research Application #1: Pure XR Research, it's all about XR!

The first, which has already been discussed by Mottelson et al.[11], Ratcliffe et al. [13], and Steed et al. [17], consists of XR-focused research which occurred in the lab before the COVID-19 pandemic but is now forced to be conducted fully online/remote. We refer to this type of research as **"Pure XR Research"**[1]. Although coming up with a clear classification is challenging, this includes research which investigates interactions within and for XR. For example, work that investigated how bystanders interrupt VR users [12], work that studied a novel VR authentication system [9], or work that investigated high-interaction fidelity techniques to improve flying experiences in VR [10].

3.2 Research Application #2: XR as a Proxy for Real-world Research

In addition to the above-mentioned works and the discussions around moving XR research out of the lab, the technology itself (be it VR/AR) can be particularly useful for researchers aiming to study real-world systems and user behaviour in VR rather than in the real world. Researchers often face issues in accessing special hardware for prototype development or are restricted in accessing specific study locations that would be beneficial for their research (e.g., studying users' real-world behaviour in front of ATMs [3]). In such situations, VR replications can be particularly helpful as researchers can create virtual replicas of their prototypes and the environments [7, 8]. We refer to this type of research as **"XR as a Proxy for Real-world Research".** For example, recent research has investigated the feasibility of using VR as a test-bed to study real-world audience behaviour in front of public displays [7] or to study a real-world authentication system's usability and security [8]. To further augment the discussions around remote XR studies, we draw in the following paragraph specifically links to "XR as a Proxy for Real-world Research" rather than "Pure XR Research".

Remote XR studies can enable researchers to conduct a large variety of HCI research during times where face-to-face user studies are challenging to conduct and sometimes even prohibited (e.g., during pandemics) that can (and should) go beyond traditional XR research. The fact alone that researchers can make progress through the help of remote XR studies can already justify the choice of the methodology compared to using more traditional methods that would likely result in more valid results due to their controlled setting (e.g., lab studies), but are likely not available during times where face-to-face research is prohibited. Remote XR studies can also support researchers in getting to scale. Similarly to online research (e.g., interviews, surveys), remote XR studies can be leveraged additionally to traditional research methodologies (in a hybrid study design) rather than replace those. For example, such a "hybrid model" can enable researchers to conduct a controlled lab study to investigate a system's usability while at the same time build a VR replication of the system to deploy it online and get to scale. Although it is important to be aware of potential challenges (e.g., to what extent can we combine both data sets?), such an approach can be particularly interesting and inspire future research because it enables researchers to (1) evaluate their system in two different settings (controlled vs uncontrolled [13]), (2) compare the results from two settings and pin-point differences between the more controlled setting and users' natural environment, and (3) has the potential to significantly increase the sample size and diversity by enabling researchers to run multiple study sessions simultaneously and remote. For example, there is often only one hardware prototype available (e.g., a phone-prototype with front and back display [2]). This then requires researchers to conduct a lab study and invite participants one by one to the lab. A hybrid model could be applied in situations where the hardware prototype gets evaluated in a lab study and in a second step a remote XR study is conducted to study a virtual replica of the same prototype in a deployable VR environment. That being said, such a hybrid model requires significant groundwork that needs to validate the findings and show that findings from studies on VR replicas are transferable to the real world (e.g., [7, 8]). While such an hybrid approach can be conducted in an unsupervised way (i.e., participants in the remote XR study condition go through the study without experimenter's presence), doing this also requires resilient software frameworks, app distribution platforms (e.g., Oculus 'App Lab' [4]), and effective designs not only for the user study design itself but also for the data collection process.

4 CONCLUSION & OUR POSITION

It is important to note that there is no "swiss-knife" research methodology that outshines all others. It is without question that remote XR studies come with limitations, but they open the door towards various benefits (e.g., remote in-situ experimentation, better representation of demographics). For the community to take advantage

[1]Note for the scope of this workshop paper we use XR as a substitutional term for all sorts of AR/VR/MR research to avoid confusion.

of this, and for remote XR research to see wide-scale adoption, we need to define common terminology and methodologies. We need specifically to agree on what constitutes "Remote XR Research", define the key differences between AR/ VR within this scope, and investigate the "grand challenges" to give researchers confidence about how and when to apply "Remote XR Research" for their human-centred research. With this, we can accelerate adoption and usage of this comparatively novel and highly impactful approach to evaluate human-centred systems and corresponding user behaviour.

ACKNOWLEDGMENTS

This work is supported by the University of Edinburgh and the University of Glasgow jointly funded PhD studentships. This work was also partially supported by the Royal Society of Edinburgh (award number #65040) and the UK EPSRC for New Investigator Award (EP/V008870/1) and for iCase studentship (EP/R512394/1).

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