International Workshop on Cross-Reality (XR) Interaction

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ABSTRACT

Established as separate disciplines, Augmented Reality (AR) and Virtual Reality (VR) have already positioned themselves as strong research disciplines. However, being part of the same Reality-Virtuality continuum, as presented by Paul Milgram, it is possible to envision (i) a smooth transition between systems using different degrees of virtuality or (ii) collaboration between users using different systems with different degrees of virtuality. We refer to these types of systems as cross-reality (XR) systems, which can better fulfil different modalities for a given task or context of use, and potentially enable rich applications in training, education, remote assistance, or emergency response compared to individual closed systems. This workshop will bring together researchers and practitioners that are interested in XR to identify current issues and future directions of research while the long-term goal is **to create a strong interdisciplinary research community and foster future development of the discipline and collaborations.**

CCS CONCEPTS

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

KEYWORDS

cross-reality, augmented reality, virtual reality, cross-reality interaction, virtuality

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1 INTRODUCTION

While some expect the distinctions between Augmented Reality (AR) and Virtual Reality (VR) to fade away in time [28], it is still useful to see them positioned in Paul Milgram's Reality-Virtuality continuum [23] of 'realities' with various degrees of virtual content. Being a continuum, it encompasses transitions between degrees of virtuality [1], the interaction between users located at different points of the continuum [27], or co-located mixed-reality collaboration [20]. We refer to these types of systems as examples of cross-reality (XR), which provide not only the flexibility to choose the best modality for a given task or context of use, but also involve interaction between users located in different realities, enabling rich applications in training, education, remote assistance, or emergency response. This concept of XR interaction builds on works focusing on *asymmetric interaction* [3, 12, 15, 26] that refer to scenarios where there is an asymmetry in the technologies enabling immersion in Collaborative Virtual Environments (CVEs). Where conventional CVEs typically use the same immersive technology (e.g. VR), in asymmetric interactions users interact within a shared VE via different mixed-reality (MR) technologies. Works in this area exhibit a near-equivalence in the shared CVE: the physical surroundings of a user's AR environment is typically unidirectionally replicated as 3D objects in the VR version of the CVE [12, 26]. Thus, work in this domain has so far focused on developing novel techniques to interact with content shared between users using very similar CVEs.

XR interaction extends the asymmetric design space by also considering non-equivalent VEs. We envision future MR systems that rely on scenarios where users collaborate within CVEs that are experienced differently across realities, where each user has immediate access to their own "reality" but wants to interact within the reality of the other user(s) and viceversa.

Figure 1: Examples of Cross-Reality Interaction. From left to right: Holoportation [25], FaceDisplay [16], Mini-Me [26], ShareVR [15], and Asymmetric Interaction [12].

In addition, XR interaction also involves works focusing on transition between different degrees of virtuality. The transition still faces problems mostly rooted in technology. For example (i) when combining different 'realities' together such as the dual-view problem using handheld AR caused by the difference between the AR device's perspective rendering the back-facing video stream on the device screen and user's perspective of the world [29] or latency in following micro AR instructions to be applied to the real world [7], and (ii) the abrupt switching between different "realities" when different hardware needs to be used for transitioning MR realities [1, 11].

While these and various other examples of cross-reality systems exist (see Figure 1), the overarching goal of this workshop is to firmly establish it as a new research domain, by **exploring the two main facets of these systems: transition and collaboration.** To fulfil the main goal of the workshop, we aim to **bring together students, experienced researchers, and practitioners from diverse areas interested and involved in XR design and research**. We expect this workshop to foster discussions around interaction techniques, design, feedback, strategies, control, trust, as well as privacy and ethical issues in XR research. These topics are relevant to (i) establish the current state-of-the-art and issues the field of XR is facing, as well as to (ii) establish future directions of the XR interaction.

This workshop will be a **valuable addition to the ISS programme** due to its relevance to its community. XR fits under one of the main ISS 2020 topics of interest "Interactive 3D spaces (Mixed Reality and Augmented Reality, mid-air displays, etc.) Indeed, almost 20% of papers accepted in ISS 2019 involved virtual or augmented reality. We are planning to pursue this through the programme of the workshop: the first part will focus on the (i) challenges raised above, with a keynote speaker from industry (BT Research Labs), and presentations of position and work-in-progress papers from all attendees; while the second part will focus on (ii), hands-on group activities with experts from academia and industry to address key questions for future XR research.

The workshop will take place virtually and we will accommodate for participants from different time zones.

2 ORGANIZERS

Our international organization team consists of diverse researchers from Belgium, Portugal, Finland, France, Germany, UK, and Slovenia who have organized several workshops and participated in organizing several conferences.

Adalberto L. Simeone is an Assistant Professor at the KU Leuven, Belgium. His research focuses on the fundamental challenges of Virtual Reality from an HCI perspective. He has (co-)organised several workshops, including WEVR ('15-'20) [31] and NIDIT ('19-'20) [24] at IEEE VR, Manipulating Reality at DIS '18 [30], and EPO4VR [5] at CHI '20.

Mohamed Khamis is an assistant professor at the University of Glasgow, UK. He organized two workshops at CHI, as well as at UbiComp and CHItaly. He published 70+ papers related to HCI and publishes regularly at CHI. He is active in security and privacy for virtual reality [8–10] interaction in VR [19] and novel VR applications [21].

Augusto Esteves is an Assistant Professor of HCI and Mixed-Reality at IST / University of Lisbon. His research focuses on multimodal input and tangible and embodied interaction, and he has been involved with ACM workshops as both workshop chair at ACM DIS '20, and as programme committee member at UbiComp '15 ([22]).

Florian Daiber is a post-doctoral researcher at the German Research Center for Artificial Intelligence (DFKI). His work involves 3D user interfaces and ubiquitous sports technologies particularly in the context of running and rock climbing. He co-organized several workshops such as ISIS3D [4], EPO4VR [5], UbiMount [6] and HCI Outdoors [18].

Matjaž Kljun is an Assistant Professor at the University of Primorska, Slovenia. His main research areas span across HCI including AR, VR, InfoVis, and Personal Information Management. He has co-organised several workshops such as MVAR 2018 @ ISMAR [17], iHDI 2019 at CHI [2] and conferences such as MobileHCI.

Klen Čopič Pucihar is an Assistant Professor at the University of Primorska, Slovenia. His research focuses on how to augment, modify and mediate rich sources of multisensory stimuli by using computational resources. He has organised several workshops (MVAR 2016 @ ICMI, MVAR 2018 @ ISMAR [17]) and conferences (ISMAR and AIVR).

Poika Isokoski is a Senior Research Fellow at the Tampere University, Finland. His research focuses on a range of HCI topics, e.g.: gaze in VR, input devices, and odors in VR. He has served as a CHI Associate Chair and in program committees of multiple conferences and workshops such as NordiCHI, Eurohaptics, and COGAIN.

Jan Gugenheimer is an Assistant Professor at Télécom Paris (Institut Polytechnique de Paris) inside the DIVA group working on several topics around MR. He served various chair roles at different conferences (PerDis 2020, UIST 2018, ISCT 2015) and organised workshops on Ethical HMDs at CHI 2020 [14] and Social HMDs at CHI 2019 [13].

3 WORKSHOP PLAN

3.1 Pre-workshop plans

We opened the web submission page[1] and set-up the website[2]. The website will promote the workshop and serve as a platform to present the findings and foster the growing community of XR researchers.a We will issue a call for participation, advertise the workshop, select position papers. The call for participation will be broadly distributed to different research communities interested in the workshop themes, via mailing lists (e.g., chi-announcements), social media (e.g., Facebook and Twitter), and through our personal networks. Besides inviting paper submissions, we will encourage participants to bring in new perspectives to foster group activities. Finally, submitted works will be assessed by a Programme Committee[3] comprised of both academic and industrial researchers. The committee is yet to be finalised and it currently includes: Kathrin Gerling (KU Leuven), Wolfgang Hürst (Utrecht University), Daniel Lopes (INESC-ID, University of Lisbon), Kenneth Mitchell (Edinburgh Napier University, Disney Research), Joan Mora (Inflight VR), Tanja Nijboer (Utrecht University), Francisco Nunes (Fraunhofer Portugal), Anasol Peña Rios (BT Research Labs), and Marko Tkalčič (University of Primorska).

The following are the topics of interest: (i) XR conceptual models and design principles, (ii) Interaction, transition, and visualization or perception techniques, (iii) Real-world tool use and tangibles as input to XR systems, (iv) Collaboration across the reality-virtuality continuum, (v) Input and output devices, (vi) Use cases in, e.g., education, industry, transportation, sports, healthcare, (vii) Evaluation of XR experiences, (viii) Privacy and security in XR, (ix) Any other XR related topic.

3.2 Online workshop plans

Our half-day workshop will take place exclusively online via platforms such as Mozilla Hubs[4], an increasingly popular 3D collaboration platform that is accessible to both VR and standard browser-based users. The workshop will be opened a keynote speech from industry (BT Research Labs), and followed by two group activities. supported via Miro whiteboard[5].In the first, participants will identify research challenges and opportunities in XR interaction. They will then present their results and then identify shared themes to discuss further in the second group activity. The activities will include one-to-one pairing to encourage ideation and exchanging feedback among participants who do not already know each other. Finally, they will share the results of the group discussion as a short presentation with the rest of the participant. We will conclude by an open-discussion on ways forward for this research area and further opportunities for collaboration among the participants. In case of a large number of participants we will plan to run the workshop in two to three different time zones to accommodate more participants to actively participate in the workshop. The workshop will be closed and moderated. However, we plan to stream the workshop over Twitch or similar platforms. We will use platforms such as Gather.Town, Mozilla Hubs and Zoom and combine online and recorded activities to make the workshop as interactive as possible.

3.3 Post-workshop plans

We plan to leave the workshop web site up and running and have the papers available for interested stakeholders. The web site will also serve as the entrance point for the future activities presented below. We are planning to submit a report article about the workshop at e.g. IEEE Access, or ACM Interact. Depending on the state of research presented in the accepted papers we will plan to hold an open call in a special issue of a relevant journal as well. With one of the workshop aims being to establish future directions of the XR interaction, we will also hold a discussion for possible ways of strengthening the XR community and further promote the field through various project proposals such as the European Research Council calls Marie Skłodowska-Curie Innovative Training Networks (ITN) and COST action. We are currently preparing to submit the ITN proposal at the end of the year and will start preparing the COST action to further the field beyond Europe. The workshop will serve as a platform for future collaborations among participants.

[1] EasyChair submission page for the XR workshop https://easychair.org/conferences/?conf=xr2020

[2] Workshop website https://xr.famnit.upr.si/

[3] https://xr.famnit.upr.si/#pc

[4] Mozilla Hubs online collaboration platform https://hubs.mozilla.com/

[5] Miro collaborative online platform https://miro.com/

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