Transitional Interfaces in Mixed and Cross-Reality: A new frontier?

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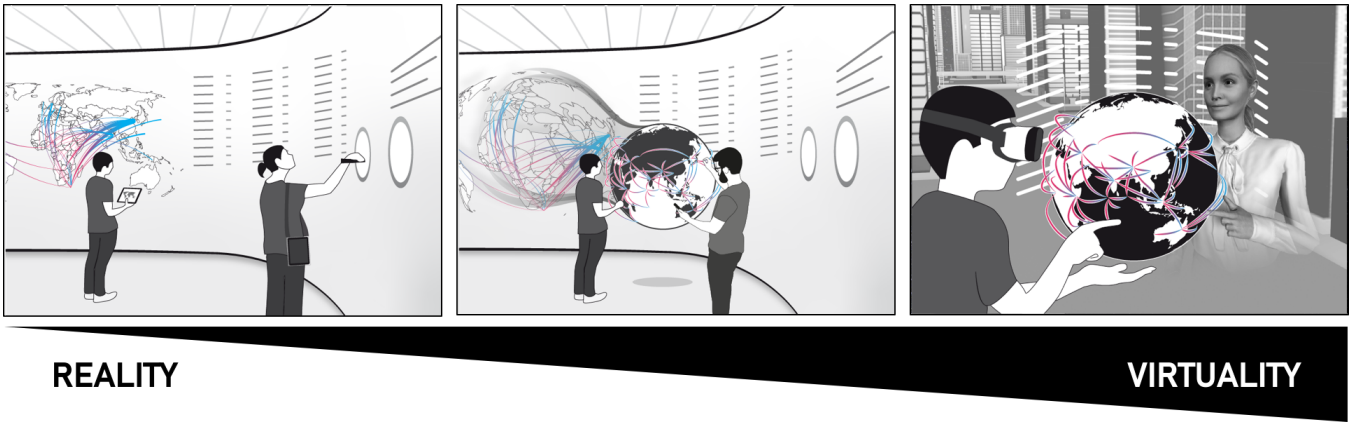

Figure 1: *Transitional Interfaces* (TI) enable users to move between different locations within the reality-virtuality (RV) continuum. They enable users to choose the technology that best supports the task at hand and fulfils their information need.

ABSTRACT

Transitional interfaces (TIs) and related concepts such as *cross-reality* (XR) or *cross-virtuality* (XV) are key topics for future HCI and AR/VR research. Future TIs will enable users to freely move between different locations within the reality-virtuality continuum during work, to choose the best technologies for their task at hand and current information need. Our workshop will explore the core advantages and challenges of TIs and related concepts and address them in presentations and workshop activities at ACM ISS 2021.

CCS CONCEPTS

• **Human-centered computing → Mixed / augmented reality**; *Collaborative and social computing devices.*

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KEYWORDS

transitional interfaces, mixed reality, cross-reality, cross-virtuality, cross-device interaction

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1 INTRODUCTION

The rapid proliferation of powerful, yet affordable, off-the-shelf AR/VR head-mounted displays (HMDs) raises questions about how to better integrate such mixed reality technologies into our real-world computing ecosystems and into the real-world physical spaces they inhabit. Currently, application domains for AR/VR technologies such as visual analytics [23, 32, 33], remote assistance [2, 27, 30], training [12, 37, 38], 3D modeling using 2D & AR simultaneously [31], or prototyping interactive spaces in VR [22] are only beginning to benefit from seamlessly integrating well-established systems

such as mouse- or keyboard-operated PCs or interactive surfaces like tablets or large touch screens with AR/VR experiences.

We believe that in the future the concept of *transitional interfaces* (TIs), which was initially introduced in form of the "MagicBook" by Billinghurst et al. in 2001 [4], will provide a key lens through which mixed reality systems should be analysed, understood, and designed to achieve better integration. Billinghurst et al. already envisioned a system that enables a team of users (e.g. an architect and her clients) to move seamlessly between reality and immersive virtual reality while collaborating on the task at hand in the same physical space [4]. In future systems, teams or individuals can seamlessly transition from collaborative 2D interaction with mobile or large screens located in *reality* (e.g. maps or plots as overviews, Figure 1 left), to also interacting with stereoscopic *augmented reality* content (e.g. 3D globes as detail view, Figure 1 center), to collaborating in immersive *virtual reality* systems (e.g. immersive 3D visualization of a location, Figure 1 right).

Grasset et al. formulated theoretical models for TIs in 2006 [14] and also proposed a set of guiding research questions for TIs that remain both relevant and unanswered to this day. In 2012, Carvalho et al. evaluated a TI with regard to its perceptual, functional, and cognitive continuity during transitions in user studies [6]. Still, TIs remain underexplored in HCI and AR/VR research. Our workshop intends to change this by establishing a dialog in the ACM ISS community and particularly between researchers who are working on TIs or related concepts, such as XR/XV.

1.1 Transitional Interfaces - A new frontier?

We believe that similar to how *cross-device interaction* [5] has blended tabletop computers, digital whiteboards, and mobile devices with our familiar physical and social environment in meeting rooms [21] or even desk lamps [29], *TIs* could allow us to seamlessly integrate systems from different locations along the RV-continuum [24] as usable, consistent, and coherent user interfaces in a shared physical space (see Figure 1). This could help achieve "a seamless integration and transition between conventional 2D visualization, augmented reality and virtual reality in order to provide users with optimal visual and algorithmic support with maximum cognitive and perceptual suitability, depending on their current tasks and needs" [33].

Prior work has explored similar concepts: In their ISS 2020 workshop on XR, Simeone et al. envisioned interfaces that enable "(i) a smooth transition between systems using different degrees of virtuality, or (ii) collaboration between users using different systems with different degrees of virtuality" [35]. We therefore regard XR as closely related to TIs and aim to foster a critical dialog, especially about the definitions and boundaries of XR in comparison to TIs.

In other related work, Reipschläger et al. and Langner et al. use AR to augment interaction and visualization on 2D interactive surfaces [23, 31, 32]. Guggenheimer et al. bridge the worlds of non-VR and VR users during gaming with a mobile handheld display that serves as a see-through interface into VR [16]. Similar cross-device interaction was later explored by Olin et al. to support collaborative work [26]. At ISMAR 2020, George et al. investigated the design space for seamless, bi-directional transitions along the RV-continuum [13]. Further, Pointecker et al. explore the audiovisual design and animation of such transitions in their research on XV analytics [28].

Despite this prior work, we perceive a lack of consistent models, definitions, terminology, and technologies in this space. Therefore, this workshop aims at bringing together researchers who are working on TIs or related concepts such as XR and XV to create a common ground and mutual understanding for developing this space further. We believe that ACM ISS is an optimal venue for such work since it brings together the extensive experience of researchers in the field of interactive surfaces and spaces including *cross-device interaction* and the AR/VR/XR/XV community.

1.2 Focus Topics

Focus topics of the workshop include but are not limited to:

(1) **Defining TIs:** Identify differences and commonalities between *transitional interfaces* and related terms and terminologies (e.g. *cross-reality*, *cross-virtuality*, *hybrid user interfaces*).
(2) **Designing TIs:** Compare and discuss designs of interaction and visualization techniques that support seamless transitions while maintaining situational and group awareness.
(3) **Evaluating TIs:** Develop cognitive models or constructs for "seamlessness", "continuity", or other important qualities of TIs and discuss how to "measure" them in user studies and experiments.
(4) **Building TIs:** Discuss and compare hard- and software that especially supports or hinders seamless transitions, e.g. video-based vs. optical see-through, different AR/VR engines, and platforms for networked virtual environments.

2 CONCEPT OF THE WORKSHOP

The workshop will be held as a hybrid, full-day event on *Nov.* 14^{th}, *2021* at ISS 2021 in Łódź. There will be contingency plans for switching to a virtual-only event if the COVID-19 pandemic should not allow for holding a hybrid meeting. Participants who join the workshop only virtually will be able to connect to the workshop room in Łódź using a remote meeting infrastructure, i.e., dedicated cameras/microphones for meetings, Cisco Webex (including installation-free Web clients), Miro for shared whiteboards. This infrastructure will be hosted by the university of the primary organizer and made available free of cost to all workshop participants.

If, in the case of a virtual-only event, the number of participants, their available equipment, and infrastructure should allow for meeting entirely in VR, this will be considered by the organizers. However, we will generally give priority to trusted and stable technologies for collaboration over novel and playful experiences.

2.1 Before the Workshop

After acceptance of the workshop, the workshop webpage[1] will go online and the call for workshop papers will be distributed across relevant HCI/AR/VR mailing lists.

The workshop will be a closed event and participants will need to apply for participation by submitting a 2-4 page position paper by *Oct.* 18^{th}, *2021*. Suitable position papers will be selected by the organizers and will be published on the workshop website. There

[1] Workshop website at https://idux-jetter.org/ti-iss21

will be no printed publication of position papers, but a journal theme issue, or special issue, on TIs will be discussed at the workshop.

To keep the submission and selection process as simple and accessible as possible, a standard ACM template will be used and position papers will be collected by e-mail and without the use of a conference system. The selection process will ideally be completed before the early bird registration deadline of ACM ISS 2021.

2.2 At the Workshop

The day of the workshop will be divided into four phases:

- **Phase 1 (09:00 to 10:00)** will be dedicated to invited talks by senior researchers and organizers to establish common ground about the history, terminology, and goals of transitional interfaces and related concepts.
- **Phase 2 (10:30 to 12:30)** will feature presentations of all submitted position papers.
- **Phase 3 (14:00 to 15:30)** will involve work in four breakout groups on the four focus topics (see above). However, topics may also be adapted dynamically based on conversations at the workshop.
- **Phase 4 (16:00 to 17:00)** will be used for breakout groups to report back to the workshop, discuss outcomes, and publication options, and wrapping up the overall event.

3 ORGANIZERS

Hans-Christian Jetter is Professor of Interaction Design and User Experience at the University of Lübeck. His research focuses on combining collaborative interactive surfaces and spaces with AR/VR for human-data interaction and information visualization. He has published award-winning papers at CHI, ITS/ISS, and CSCW for the last 10 years [20, 22, 25, 29] and has organized workshops at CHI, AVI, and ITS/ISS.

Jan-Henrik Schröder is PhD student at the University of Lübeck focusing on collaboration in transitional interfaces.

Jan Gugenheimer is an Assistant Professor of Computer Science at the Institut Polytechnique de Paris (Telecom-Paris), France. In his research, Jan explores upcoming issues that arise when AR/VR technology is starting to be used more frequently outside the users homes. One of the issues he focused on in the past are asymmetric interactions that allow immersed and non-immersed users' to collaborate with each other without the need to have access to the same technology [17–19].

Mark Billinghurst is Director of the Empathic Computing Laboratory, and Professor at the University of South Australia in Adelaide, Australia, and at the University of Auckland, New Zealand. He earned a PhD in 2002 developing some of the first collaborative AR systems [3]. Since then he has published over 600 papers on AR, VR, remote collaboration, empathic computing, and related topics. Beginning with MagicBook [4], he has published many papers on transitional Mixed Reality interfaces [15, 36].

Christoph Anthes is Professor of Augmented and Virtual Reality and the head of the Human Interfaces and Virtual Environments (HIVE) group at the University of Applied Sciences Upper Austria. He leads the X-PRO five-year project on cross-virtuality analytics and has published about the intersection of HCI, VR, and visualization [1, 7, 11, 22].

Mohamed Khamis is an assistant professor at the University of Glasgow, UK and has organized workshops on cross-reality interaction [35] and usable security for extended reality[34]. He leads the SIRIUS research group, which has received funding from the UK Research Council, Facebook Reality Labs, the Royal Society of Edinburgh and more.

Tiare Feuchtner is Assistant Professor at the Human-Computer Interaction group at the University of Konstanz. Her main interests are the study of HCI with a focus on embodiment and novel user interfaces for immersive technologies [8–10], as well as multi-user interaction and asymmetric collaboration in AR and VR [26].

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