



Emerging Telepresence Technologies for Hybrid Meetings: an Interactive Workshop

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ABSTRACT

We are rapidly moving to a hybrid world, where telepresence technologies play a crucial role. But, are current technologies ready for such a shift? Do they provide adequate support for interaction and collaboration? In this workshop, together with the participants, we will try out a variety of telepresence technologies for hybrid meetings. Based on small hybrid group activities we will explore how different systems compare in terms of immersion, interaction, and usability. Additionally, we will reflect on the social implications of telepresence. The aim of the workshop is to bring together the lived experiences of both remote and local participants, with activities that stimulate reflections on our experiences. These reflections will fuel group discussions, to identify future research areas in telepresence and hybrid meeting technologies. Results from the workshop will be published as a white paper with recommendations for the design of future telepresence and hybrid meeting technologies.

CCS CONCEPTS

• **Human-centered computing** → **Collaborative interaction**;
Mixed / augmented reality; **Interaction devices**.

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KEYWORDS

telerobot, videoconferencing, computer-mediated communication, remote collaboration, mixed reality

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1 BACKGROUND

Hybrid work can make work and education more accessible for people who might have otherwise been excluded [2, 8, 9, 14, 22]¹. CSCW has contributed greatly to understanding remote collaboration [35, 45, 47], but despite recent research [19, 27, 38], we are far from “solving” the challenges of hybrid interactions. One concern is ensuring equal participation for all attendees. When different modes of participation are used, there is an asymmetry in how attendees access the interaction, with some facing more limitations than others [10, 18, 34, 49]. It is easy for local attendees to talk among each other and forget about their remote peers. Moreover, even in “successful” meetings [15, 28, 31], the effort of compensating for the limitations can result in fatigue [5, 21, 24, 37]. Beyond structured meetings, physically distributed teams may experience

¹Hybrid here refers to meetings by physically distributed attendees, who may also be attending through different media (e.g., a workshop attended by people in-person and via videoconferencing).

more isolation within their workflow and miss out on the benefits of spontaneous encounters [7, 36, 46]. Emerging telepresence technologies might be a promising solution.

One example is mobile robotic telepresence, combining a remotely controlled, robotic body with video conferencing, to give the user autonomy of movement [29]. Studies report that remote users feel more present [30, 42, 48], but also suggest that its use can be challenging [3, 6, 13, 20, 26, 30, 39–41, 48]. Other technologies, like tabletop robotic solutions and extended reality [43], which allow the transition from 2D to 360° video, should also be explored.

Previous workshops and panels have looked at collaboration technologies and blended reality to create better hybrid engagement [16, 17, 19, 23, 38]. Workshops at CHI 2020 and 2021, "Social VR: A New Medium for Remote Communication & Collaboration", run in a Social VR platform, Mozilla Hubs, exploring the experience of the participants and the existing limitations [32, 33]. At ISMAR 21, a contest invited participants to submit innovative AR, VR and Mixed Reality solutions that support "natural" hybrid social interactions [1]. More recently, at CHI 2023, the SIG group *Reflecting on Hybrid Events*, highlighted the problems and trade-offs between hybrid functionalities for conferences [4]. In this workshop, we combine the approaches of Social VR and mobile robotic telepresence, aiming to move beyond the "strict" version of a tablet with 2D video on a remote base.

In this one-day, hybrid workshop, participants will trial telepresence technologies, examine how their capabilities add to the interactions and discuss future directions. We will bring three different systems, and invite participants to bring systems they wish to test and discuss. During the workshop, we will try these systems in group activities that simulate meeting scenarios. Then, we will discuss what we learnt and how research should move forward. The aim of the workshop is to bring together people with interest and knowledge in this field, but also draw on our shared lived experiences, consolidate our understanding and set meaningful directions for future work.

The topics we expect to discuss are:

- What capabilities matter in interaction
- Main challenges for hybrid meetings
- Autonomy and automation in mediated interaction
- Mixed reality for hybrid meetings
- Supporting accessibility and inclusion
- Requirements for physical spaces
- Transferable learnings from CSCW work on videoconferencing

1.1 Hybrid engagement

Given the interactive structure of the workshop, we can accommodate a limited number of participants to ensure that everyone has a good experience. We can support about 20 local and 15 remote participants. For the minimum of 3 systems (see section 2), the interactive sessions will split among three teams of 6-7 local participants and 1-3 telepresent participants, with remote participants taking turns so that every remote participant tries one system. With more systems, we can have smaller teams, and allow remote participants to try more than one system.

We will use Microsoft Teams for remote participation, and breakout rooms will be used during the interactive sessions to allow remote participants not on the telepresence systems to follow the activities. Workshop organisers will also be taking photographs of material created during the activities and discussions. (e.g., post-it notes, sketches) and posting them on the chat for remote participants to view. Teams will also be used for asynchronous chat and file sharing, leading up to and after the conference. The accepted papers and information about the systems will be on the website for attendees to view in advance.

1.2 Accessibility

To support accessibility, we will use Microsoft Teams, which has background blurring, is screen reader accessible and allows for live captioning in US English. Further, we will ensure that the website complies with the Web Content Accessibility Guidelines (WCAG), that position papers are in accessible PDF and that videos about the systems (section 7.2) are captioned. Unfortunately, we can not ensure that the systems used for the interactive session will be accessible, as they might be early prototypes or by small companies. However, we encourage people with disabilities to attend and try the systems, as their input in the discussions would be highly valuable.

2 SYSTEMS

We aim to have 3 to 6 systems available for the interactive part of the workshop. To ensure there are enough systems, we will provide 3 systems (Figure 1):

- The Double 3, is a conventional mobile telepresence robot that allows the user to move in the environment [44].
- The Kubi is a tablet robotic stand. It uses interactive two-way video and allows the user to look around with 300° of pan and 90° of tilt [25].
- The Owl [27] is an immersive telepresence system based on 360° video. Remote participants can join the hybrid meeting using a Head-Mounted Display (HMD), a smartphone, or a tablet. They are represented locally by computer-generated avatars displayed on a screen. Up to three people can use this system at the same time. It received an honorable mention (second prize) at ISMAR 2021.

Participants can bring systems, either developed or just used by them, through a specific Call for Systems (Section 7.2). This is an opportunity to system developers and researchers to receive feedback on their systems. Systems will be selected based on their technical features, as well as searching for variety. The following aspects will be considered in the exploration of systems:

- Immersion: video quality, field of view, use of immersive video, spatial audio, etc.
- Physical interaction: mobility, navigation capabilities, other interaction tools (robotic arms, pointers, visual cues, etc.).
- Convenience: reduced size, portability, solutions for multiple simultaneous remote users, ease of use, etc.
- Experience: social and/or user experience of the system, considering both local and remote users and bystanders (non-users).

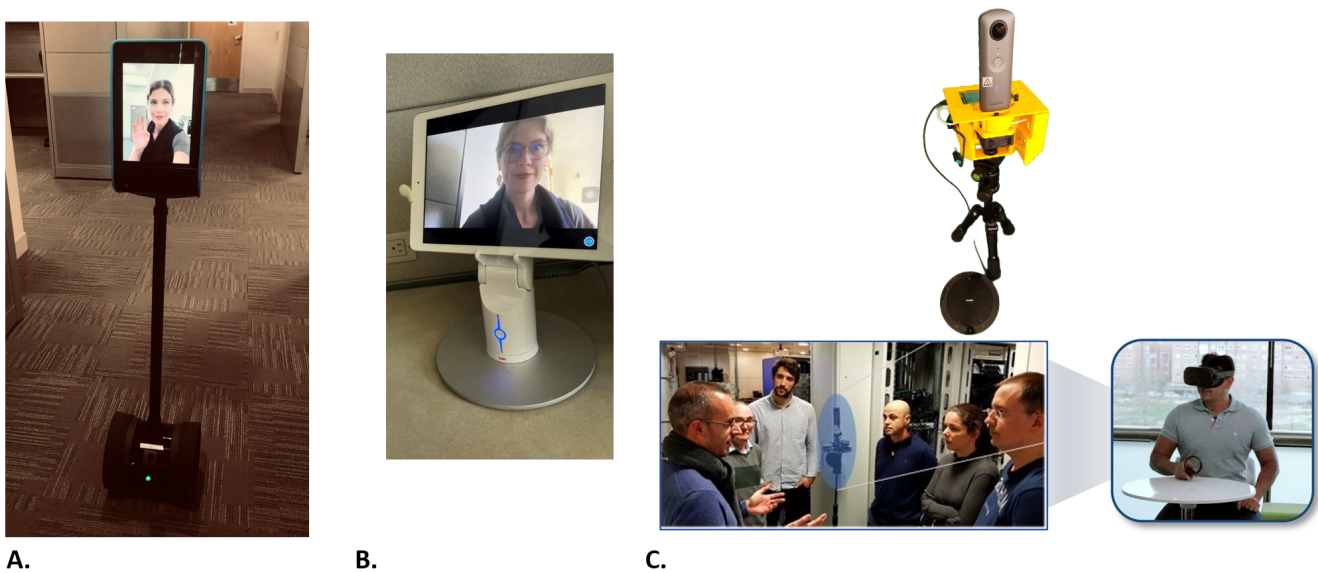


Figure 1: Telepresence systems: A. Double 3 by Double Robotics, B. Kubi by Kubi, C. The Owl by Nokia Bell Labs

3 ORGANIZERS

Andriana Boudouraki is the main contact for this workshop. She is a PhD student at the Mixed Reality Lab, at the University of Nottingham. Her research examines interactions via mobile robotic telepresence [10–13].

Houda Elminouni is a Computing Innovation (CI) Fellow and Postdoctoral Researcher within the Department of Informatics at Indiana University Bloomington. She is currently focusing her research on mobile robotic telepresence, with a particular interest in classroom applications. She previously organized a SIG on telepresence at CHI2018 and a workshop on emerging telepresence technologies at CHI2022.

Marta Ordunais is a postdoctoral researcher at Nokia eXtended Reality Lab in Madrid, Spain. Her current research is in the area of virtual reality, video encoding and streaming, and quality of experience.

Pablo Pérez is a senior researcher at Nokia eXtended Reality Lab in Madrid, Spain. His research interests cover the whole area of real-time immersive communications and telepresence, from the compression and transmission problems to the user quality of experience.

Ester González-Sosa is a researcher at Nokia eXtended Reality Lab in Madrid, Spain. Her main research is focused on the application of computer vision algorithms to Mixed Reality applications related to fostering human communications, with a focus on real-time performance, quality of data acquisition and application.

Pablo Cesar leads the Distributed and Interactive Systems group at CWI (The Dutch National Research Institute for Mathematics and Computer Science) and is a professor of human-centered multimedia computing at the Delft University of Technology. He is an ACM Distinguished Member, IEEE Senior member, and recently received the prestigious 2020 Netherlands Prize for ICT. Pablo gave the tutorial "Interaction Design for Online Video and Television" at

ACM CHI (2011, 2012, 2014, 2015, 2016) and co-organised the workshop "Social VR: A New Medium for Remote Communication & Collaboration" (2020, 2021). Webpage: <https://www.pablocesar.me>

Jesús Gutiérrez is an assistant professor at the Image Processing Group of the Universidad Politécnica de Madrid (UPM). His research interests are in the area of multimedia processing, immersive media technologies, and evaluation of user quality of experience. He was general co-chair of the conference ACM IMX'22. Webpage: <https://sites.google.com/view/jesus-gutierrez-sanchez/>

Taffeta Wood is a postdoctoral scholar of Learning Sciences & Health Informatics in the School of Medicine, Dept. of Pediatrics and Center for Health & Technology at UC Davis. Her work is centered on the ways in which educators can leverage technology to promote equitable learning and social experiences that support literacy and mathematics development regardless of disability and/or differences.

Veronica Ahumada-Newhart is an assistant professor of health informatics and HRI in the School of Medicine, Center for Health & Technology at UC Davis. Her work is focused on the use of social robots and interactive technologies for improved health and developmental outcomes. She is PI of an NSF grant on Robot-Mediated Learning and is co-PI of a Univ. of California, Office of the President grant to explore the use of telerobots for healthcare worker safety and community social inclusion.

Joel Fischer is Professor of Human-Computer Interaction at the School of Computer Science, University of Nottingham, UK. His research takes a human-centred view on AI-infused technologies to understand and support human activities and reasoning. He is currently Research Director on the UKRI Trustworthy Autonomous Systems (TAS) Hub where he is involved in a number of projects on HRI and Telepresence. He has co-organised a number of workshops at international conferences like CHI and CSCW and in the past.

4 PRE-WORKSHOP PLANS

We will publish a Call for Participation in all relevant venues including HCI, HRI, and UX mailing lists and social media platforms, we will actively target the CSCW community on Facebook and the Assets mailing list, as well as the target sts-grad, Labor Tech and AoIR mailing lists. We will use our website to provide relevant details for submission and to answer questions from participants.

5 WORKSHOP STRUCTURE

This workshop will run for one day. We will begin with a welcome and lightning talks. Then we will have the interactive session, where participants will split into small groups and use the telepresence systems. We will plan activities that make sense for the systems and encourage experimentation and play. For example, for the Double 3, participants might be asked to brainstorm and categorize the benefits and limitations of the technology using post-it notes. Thus, the telepresent participants will be able to move around the table to look at the different notes and engage with the local participants. Although activities for each system will be different, they will have similar aim, to allow for some comparisons. For each system we will plan to have one activity that is informal and social (e.g., getting to know the other attendees) and one that is more task-driven (e.g., brainstorming).

The second part will be comprised of discussion sessions based on the position papers and the interactive session. To begin, participants will be asked to provide individual feedback for the telepresence systems they used. Questions will be related to both system and user experience and will focus on human communication rather than technical system features. We will discuss our experiences in order to identify strengths and weaknesses of the different systems and user modalities. Last, we will create groups to think and brainstorm about opening challenges, new research questions and directions for future work.

6 PROVISIONAL TIME SCHEDULE

9:00: Coffee & Prep
 9:30: Introductions & Welcome
 10:00: Lightning Talks
 10:45: Coffee break
 11:00: Interactive session
 12:30: Lunch break
 14:00: Interactive session
 14:45: Discussion - Individual Feedback
 15:15: Coffee break
 15:30: Discussion - Groups
 16:45: Closing

7 CALL FOR PARTICIPATION

This workshop is for researchers and designers who are interested in studying or developing telepresence technologies for hybrid meetings and collaboration. We invite two types of contributions: position papers and systems.

7.1 Call for position papers

Workshop participants are required to submit position papers of between 2 to 4 pages in the ACM Journals Primary Article format.

Participants should further include details about their research interests, a short motivation statement describing why they want to participate in this workshop, and their experience with telepresence or hybrid meetings research. Potential topics for papers may include:

- Emerging telepresence technologies used in hybrid interactions
- Case studies of telepresence technologies used in hybrid settings
- Challenges surrounding the use of telepresence technologies
- Best use practices for workplaces, education or other spaces that use telepresence technologies
- Ethics and social norms for inclusive use of telepresence technologies
- Telepresence technologies for people with medical conditions and/or disabilities
- Design methods and principles for the development of telepresence technologies
- Novel or innovative research methods for studying telepresence technologies' user experiences

Submissions will be reviewed based on relevance, diversity of topics, and the quality of the position papers by the workshop organizers. At least one author of each accepted paper must register for the workshop and attend at least one day of the main conference.

7.2 Call for systems

System proponents are required to submit a short paper (in ACM Journals Primary Article format, 2-6 pages) describing a system that can be used to host, participate in, or facilitate in any way hybrid meetings. The system may have been developed by the proponents, but it is not mandatory. The system must have enough technological maturity to be used in the workshop "off-the-self".

The paper must cover at least the following sections:

- (1) Overview. General description of the system.
- (2) Technical characteristics. Including:
 - (a) Immersion: video quality, field of view, use of immersive video, spatial audio, etc.
 - (b) Physical interaction: mobility, navigation capabilities, other interaction tools (robotic arms, pointers, visual cues, etc.)
 - (c) Convenience: (approximate) dimensions, number of supported users, devices required, other requirements (connectivity, power, etc.).
- (3) Experience: describe the social and/or user experience of the system, considering both local and remote users and bystanders (non-users), in two hybrid meeting scenarios of your choice, with the following topics:
 - (a) Interaction in an informal/natural setting (e.g. entering a meeting, introducing yourself, leaving the meeting, handling a coffee break, etc.).
 - (b) Interaction in a discussion context (e.g. whiteboard session, design sprint, brainstorming, etc.).
- (4) (Optional). A description of the features (strengths and challenges) that the proponent would like to get feedback for. This section can be removed from the published version, if requested by the proponent.

Submissions will be reviewed based on the characteristics of the system (immersion, physical interaction, convenience, experience). At least one author of each accepted system must register for the workshop and attend at least one day of the main conference. They must bring the system to the conference, configure and operate it. They must also provide a video description of the system (2-5 minutes) in advance, so that workshop participants have time to understand how it works.

Please submit your paper via email to: telepresence4hybridmeetings@gmail.com. More details about the submission for this workshop can be found on our workshop website: cscw23emergingtelepresence.wordpress.com

8 POST-WORKSHOP PLANS

Our aim for this workshop is to produce an article or white paper for ACM Interactions discussing the present state of telepresence technologies for hybrid meetings, outlining what is missing and setting an agenda for future work. Workshop participants will be invited to collaborate on this.

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