Mobility and Utility in Robot Mediated Interaction

An Interactive Workshop for the Identification of Use Cases and Affordances of Telepresence Robots

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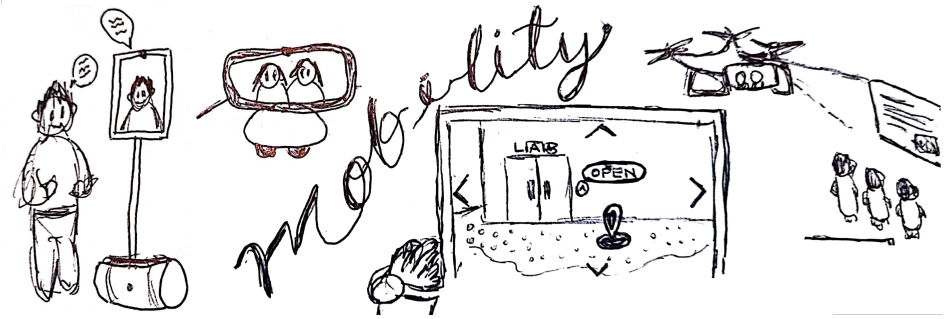

Figure 1: Teleoperation now, and how it could be.

ABSTRACT

In recent years virtual meetings have become the predominant alternative to face-to-face meetings. Ongoing efforts in the design of telepresence robots promise remote access to physical settings and a greater sense of presence, leading to improved remote collaboration. However, a comparable sense of physical presence and utility has yet to be achieved. Mobile telepresence still provides limited ways to interact with remote users (e.g., with the environment and other people). This workshop aims to re-imagine telepresence robots, moving away from the decades-old 'iPad-on-a-stick' paradigm. Using interactive activities involving existing telepresence robots and a hybrid workshop format, we hope to ideate ways of expanding the capabilities of mobile telepresence robots through a range of mechanisms (e.g., mobile and wearable technology, Augmented Reality, Internet of Things, etc.) and to inform the future design of these devices to provide additional affordances. In doing so, we plan to identify use cases for which mobile telepresence robots can provide additional value through their locomotive capabilities compared to current screen-based remote interactions. Lastly, we aim to identify scenarios for future research in Mobile HCI using use cases and affordances identified during the workshop to support more equitable participation for remote users.

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CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; *Accessibility technologies*; **Ubiquitous and mobile devices**; **Ubiquitous and mobile computing design and evaluation methods**; • **Computer systems organization** → **Robotics**.

KEYWORDS

mobile telepresence robot; remote presence; telepresence affordances; telepresence use cases

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1 INTRODUCTION

The COVID-19 pandemic has exposed the unpreparedness of telepresence in various contexts. Online meeting platforms like Zoom, MS Teams, and Discord have been adopted, but challenges in hybrid interaction persist, including room dominance in hybrid meetings [23, 24]. While current solutions are a step towards addressing these issues, open-ended questions remain [24, 27].

As online meeting platforms become more widely used, telepresence robots, such as the Double 3 robot, are presented as the next step for remote workers and students to have a physical presence. HCI research has also seen an increase in telepresence robot research[1]. However, the embodied design philosophy has not evolved. The 'iPad-on-a-stick', (e.g., [3, 9]) design is still prevalent in current telepresence robots, such as the Double 3 and the Ohmni telepresence robot, but need not be the only form of robotic telepresence (e.g., [12]) .

This limited utility is further aggravated by their problematic collision-free navigation [19] in crowded environments (e.g., conference venues), as well as their lack of remote manipulation capabilities (e.g., in elevators or outdoors [14]). While these robots are touted as the 'solution' for hybrid meetings, teaching, or conference participation, we argue that the capacity for locomotion does not inherently make the medium superior to static videoconferencing. We should think more critically about the contexts in which locomotion truly adds value, and in what ways it should be implemented. Moreover, we should consider how other existing technologies can be integrated into mobile telepresence robots to fulfil those purposes, for instance by exploring augmenting robotic telepresence with smart devices and third-party services (e.g. [22]).

Goals for the workshop. With this first workshop on 'Mobility and Utility in Robot Mediated Interaction' we hope to:

(1) Re-imagine telepresence robots by identifying **use cases** in which telepresence robots with locomotion **truly add value** compared to classic remote meeting platforms,
(2) Identify **affordances** that are desirable to increase the utility of these mobile devices, leading to more **equitable participation from all participants** and **a stronger feeling of presence** for the remote operator,
(3) Inform an **expanded design space** for mobile telepresence robots which may integrate a range of mechanisms such as mobile and wearable technology, augmented reality, internet of things, and AI powered features.

We also plan to synthesise the results of the workshop in an ACM Interactions article. Participants who are interested in contributing will be invited to collaborate on this effort. Furthermore, we wish to spark new collaborations across diverse disciplines, and identify future directions for the field of tele-robotics; we will discuss the possibility of establishing a medium for communication and networking such as a Slack workspace or a Discord server. Lastly, depending on the fruitfulness of discussion, we will consider creating a special issue on mobile telepresence robots in an appropriate journal.

[1]Search term 'telepresence' for the CHI conference in the dl.acm.org: 2 results for 2007, 33 results for 2022

2 BACKGROUND

Although research on telepresence robotics is not new, limited research has been conducted to identify use cases for telepresence robots [28]. Nevertheless, various studies have investigated operators' self-awareness in the remote environment [11, 13, 26], social expressivity and remote presence's feeling of 'being together' [1, 5, 16], physical features of telepresence robots in hybrid interaction [7, 20], and remote participants' ability to manipulate physical objects [15, 25]. Tsui et al. [28] studied telepresence robot use cases in the office context, with an emphasis on "conference room meetings" and "moving hallway meetings." They found that there is no need for locomotion in conference room meetings, and that even in walk-and-talk situations, the interaction is less natural than human-human interaction, which may relate to the robot's walking speed and height. Rae et al. [20] studied how the telepresence robot's height affects interaction, emphasizing the importance of careful design. With the evolution of remote and hybrid work and the impact of the Covid-19 pandemic [21], exploring use cases for mobile robotic communication is valuable.

Some studies have looked more specifically at the movement of robotic telepresence systems. Nakanishi et al. [17] compared the use of fixed, rotatable, moveable backwards and forwards but unrotatable, completely movable, and automatically moving robots during a lab demo to find that users felt more present in the user-controlled movable robot conditions. Similarly, Rae et al. [18] found that using a mobile robot—compared to a stationary one—in collaborative tasks led to increased feelings of presence, especially in tasks with higher mobility requirements. It did, however, also lead to decreased task performance. Another study by Choi et al. [8] comparing no-movement, random movement and mimicry during a conversation found that male participants and participants scoring high in self-monitoring preferred the movement conditions. Bamoallem et al. [2] investigated the possibility of head movement to enable more non-verbal communication by comparing static video conferencing with a set-up where the screen moved in a way that replicated the remote participants' head movements but did not find any significant results. Still, some studies have called for robots to have more degrees of freedom of movement and for the robot's head to move as separate from the movement of the entire robotic body [4, 10, 28]. Overall, the existing literature suggests that user-controlled movement relates to feelings of presence, and this effect may be in some ways moderated by type of task or user characteristics. However, there may also be negative effects of movement on task performance, which further highlights the importance of a holistic and research-informed design process when implementing movement in communication. Joshi et al. [13] in their use of telepresence robots for an intergenerational program studied how limitations of movement shape the physical and emotional experience of the pilot and translate into the pilot's bodily and sensory connection with the interfaces and the robot in addition to the environment in which the robot operates. They presented their ideas on piloting movements of the robots to provide an outlet for

self-expression for the pilot. We can take this literature as an indication that movement in mediated interaction matters, but there is much more scope to explore in exactly what context this is the case and in what ways.

3 THE WORKSHOP

In order to increase awareness about the workshop, thereby making sure that we get a diverse cohort of participants, we will create a workshop webpage (https://sites.google.com/view/mobilehci23-telepresence-ws) and advertise the workshop through our social media as well as personal connections and university mailing lists.

The webpage will contain all relevant information about the workshop, the call for participation and our contact details. In addition, prior to the workshop we will make all accepted position papers available on the webpage, thereby providing participants with the opportunity to read these in advance.

3.1 Workshop accessibility and inclusivity

To ensure that the workshop is as accessible and inclusive as possible we will conduct it in a hybrid format and provide options for asynchronous access to the workshop material. We will ensure that the workshop webpage is screen reader accessible and abides by accessibility standards (WCAG 2.1). Further, we will ask that all accepted camera-ready submissions are provided in accessible PDF format, these will be shared with all participants in advance. We will offer support to workshop participants to make their PDF submissions accessible if needed.

During the workshop remote participants will be able to attend via MS Teams, which supports background blurring, is screen reader accessible and allows for live captioning in US English. Teams may also be used by participants before and after the workshop for asynchronous chat and file sharing.

As the planned activities (see Section 3.2) will involve ideation around telepresence robots, we will also bring Double 3 robots. These will allow remote participants to connect virtually, thereby further increasing the possibilities for participants not able to partake in-person at the workshop. Workshop activities will happen in virtual breakout rooms as well as on-site. The on-site activities will be replicated using virtual whiteboards such as Miro. Lastly, all the material (e.g., keyword cards, see Section 3.2) will be available online and can be accessed asynchronously with a description of the associated workshop activities for some time, both before and after the workshop. Through these measures, i.e., Teams and Double 3 remote access as well as asynchronous access to the material, we attempt to be as inclusive as possible for both on-site as well as virtual workshop participants.

3.2 Workshop structure

The workshop is planned as a half-day workshop. We plan to start with brief introductions as well as speed presentations (approx. 5 minutes) of the accepted position papers. This will be followed by two activities, with two breaks planned in between. Specifically, the first activity is designed to investigate the first overarching question, while the second activity targets the investigation of question two and three (see Section 1).

The first activity will be a structured brainstorming on use cases, using keyword cards as conversation starter. These keyword cards will be developed by the workshop organisers prior to the workshop; they will be made available to participants before the workshop on the workshop webpage. The keywords will be based on topics of interest as expressed in the accepted position papers. In addition to the keyword cards, participants will be encouraged to utilise pre-designed props, e.g., fictitious cardboard robot parts created by us and sketching material. Each group should conclude Activity 1 with, at least, one concrete use case in which they believe mobile telepresence robots can provide actual value. Following the first activity, each group will have five minutes to present their use case as well as the discussions and thoughts leading to the selection of it. This will be followed by the first break.

After the break we will continue with Activity 2, which will be inspired by think.design's Bodystorming technique [6]. Bodystorming combines brainstorming with physical roleplay, and is based on the enactment of scenarios in the users physical environment. For the sake of the workshop, we will be adapting the bodystorming approach to be carried out as part of the workshop and not in the wild. Specifically, each group will use supplied props, both non-digital (e.g., cardboard or foam) and digital (iPads and Double 3 robots) to enact remote interactions. The scenarios for these interactions will be based on the use cases identified in Activity 1. Just like Activity 1, this will be followed by a summary presentation by each group as well as a break. During the break the workshop organisers will synthesise the outcomes of the workshop to present a short summary, highlighting the identified use cases and robot affordances and the design space that were bodystormed, and present them to the workshop. Lastly, we will give closing remarks, as well as collect contact information of people interested in collaborating on an ACM Interactions article based on the workshop outcome. The full schedule for the workshop can be seen in Table 1.

The entire workshop will be documented using notes, pictures, and audio-video recordings of the summary presentations. Provided that consent is given by all participants during the introduction of the workshop. In order to strengthen the possibilities for community building and future collaborations amongst workshop participants and organisers, we will continue informal conversations and networking at a post workshop lunch with all interested participants.

To ensure diversity and inclusivity at the workshop, we plan two strategies. Firstly, we will consider diversity in paper selection along multiple parameters. Secondly, the workshop is planned as a hybrid event with on-site and remote participation, including the use of telepresence robots to enhance physical presence for remote attendees. The number of robots is yet to be decided, but they will be limited.

4 CALL FOR PARTICIPATION

We invite position papers for the half-day workshop on "Mobility and Utility in Robot-Mediated Interaction: An Interactive Workshop for the Identification of Use Cases and Affordances of Telepresence Robots" at MobileHCI from researchers and practitioners working in various fields related to mobile telepresence platforms. Papers should be 2–4 pages long and formatted according to the SIGCHI

Table 1: Program for the half day workshop.

09.00 - 09.15	Introduction to the Workshop	→	09.15 - 09.50	Position paper presentations
09.50 - 10.25	Activity 1: Use case brainstorm	→	10.25 - 10.40	Summary activity 1
	10.40 - 10.55 Break			
10.55 - 11.35	Activity 2: Bodystorming affordances	→	11.35 - 11.55	Summary activity 2
	11.55 - 12.20 Break			
12.20 - 12.50	Outcome synthesis	→	12.50 - 13.00	Closing remarks
	13.00 End of Workshop			

template. The papers should cover interesting points of discussion, opinions, open research questions, and ongoing or planned research related to topics such as Human-Computer and Human-Robot Interaction, Robotics, Arts, Ethics, Social Sciences, Design, and Psychology. Topics of interest for the position papers include but are not limited to:

- new imaginaries of telepresence robot interaction
- new interaction modalities for mobile remote interaction
- augmentation of mobile telepresence robots (e.g., through mobile and wearable technology, Augmented Reality, Internet of Things, etc.)
- methodologies for evaluating successful remote interaction
- improvements needed to the navigational capabilities of the telepresence robot
- concrete context in which remote locomotion is beneficial
- engaging telepresence robot embodiment
- proxemics (e.g., F-formations) during human telepresence robot interaction
- pair- or group-based remote interactions
- remote collaboration
- ethical implications of mobile telepresence platforms
- how to reduce mental workload for remote operator while manoeuvring the telepresence robot
- accessibility features for telepresence robots

All submissions will be reviewed based on relevance to the conference theme, the applied understanding of mobility, quality, and diversity. Submissions that interpret mobility broadly and relate to various topics within mobile contexts in robot-mediated interaction are welcome. At least one author of each accepted paper must register for the workshop. Please submit your paper to eike.schneiders@nottingham.ac.uk. More details about the submission for this workshop can be found on our workshop website: https://sites.google.com/view/mobilehci23-telepresence-ws. The list of accepted papers will be posted on the website and will be available for download prior to the workshop.

Submission deadline: May 26, 2023
Camera ready: July 7, 2023
Notification of acceptance: June 23, 2023
Day of Workshop: September 26, 2023

5 ORGANISERS

Eike Schneiders is a Postdoctoral Researcher in the Mixed Reality Laboratory at the University of Nottingham (UK). He received his Ph.D. in Computer Science, focusing on HCI/HRI, from Aalborg University, Denmark, focusing on non-dyadic HRI. He has been working with HCI/HRI for the last five years and has several publications at premiere venues (e.g., CHI, THRI, CSCW). His current research interests are within the investigation of trustworthy collaboration in human-robot teams.

Andriana Boudouraki is a Ph.D. student at the Mixed Reality Laboratory at the University of Nottingham (UK). Her thesis examines how users conduct interactions via mobile robotic telepresence and explores how the technology fits into the workplace. Her research interests include hybrid participation, human robot interaction and interaction with autonomous systems. She has publications at CSCW, CHI and HRI.

Gisela Reyes-Cruz is a Postdoctoral Researcher based in the Mixed Reality Lab at the University of Nottingham (UK) currently investigating collaboration with, trust in, and the feasibility of, autonomous and robotic systems. Gisela completed her Ph.D. in Computer Science at the University of Nottingham; her background sits at the intersection between Human Computer Interaction, Accessibility, Ethnomethodology and Conversation Analysis.

Juan Martinez Avila is a Research Fellow at the Mixed Reality Laboratory (University of Nottingham, UK). His research work addressing the embodied practices of musicians through ethnographic studies, participatory design and embodied ideation methods—such as Soma design—has been published at TOCHI, JNMR, CHI, CSCW and NIME. His current research interests involve the use of creative AI and robotics in music making and understanding how these can be informed by first and second-person perspective methods, such as somaesthetic appreciation and microphenomenology.

Houda Elmimouni is a Computing Innovation Fellow and Postdoctoral Researcher in the Department of Informatics at Indiana University Bloomington (USA). She received her Ph.D from Drexel University in Philadelphia, USA. Her current work focuses on the use of Mobile Robotic Telepresence in the Classroom and human values. She previously organised a SIG on telepresence at CHI2018 and a workshop on emerging telepresence technologies in CHI 2022. She published her telepresence work at CHI and HRI.

Jens Emil Grønbæk is a Postdoctoral Researcher based in the Department of Computer Science at Aarhus University (Denmark). He received his Ph.D. from Aarhus University supported by Microsoft Research. His current research explores proxemics and flexible interfaces for distributed team collaboration, with the invention of new malleable systems for video conferencing, telepresence, and mixed reality meetings. With several publications at CHI, he also serves as an AC for CHI and often reviews for UIST and CSCW.

Sean Rintel studies the intersection of technology and work at Microsoft Research Cambridge UK. With a background in sociology and communication technology, he is currently exploring blended reality encounters and workflows. He serves as an AC for CHI and CSCW, organises workshops, and reviews for many conferences and journals in HCI and related fields. He has also been a part of several winning projects in Microsoft Hackathons and has multiple patents for collaboration technologies.

Swapna Joshi is a Postdoctoral Researcher and NSF Computing Innovation Fellow at the HCI-VIS Lab in UMass Amherst (USA). Her current research focuses on the social and cultural aspects of sidewalk robots, drawing from her background in Urban Design and her doctoral research on Community Robotics. She strives to incorporate stakeholder participation in the design of

mobile robots for social good. She has served on the organizing committees for CSCW and HRI conferences and publishes in HRI and related fields.

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