Virtual, Augmented, and Mixed Reality for Human-Robot Interaction (VAM-HRI)

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ABSTRACT

The 6^{th} International Workshop on Virtual, Augmented, and Mixed Reality for Human-Robot Interaction (VAM-HRI) will bring together HRI, robotics, and mixed reality researchers to address challenges in mixed reality interactions between humans and robots. Topics relevant to the workshop include the development of robots that can interact with humans in mixed reality, the use of virtual reality for developing interactive robots, the design of augmented reality interfaces that mediate communication between humans and robots, the investigations of mixed reality interfaces for robot learning, comparisons of the capabilities and perceptions of robots and virtual agents, and best design practices. VAM-HRI 2023 will follow the success of VAM-HRI 2018-22 and advance the cause of this nascent research community. **Website:** https://vam-hri.github.io

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**.

KEYWORDS

robotics, human-robot interaction, VR, AR, MR

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1 BACKGROUND

Effective human-robot collaboration requires common ground with respect to shared beliefs, desires, and intentions. This is especially important when mixed human-robot teams are involved in collaborative tasks for safety, efficiency, and ease-of-use, as emphasized in the *Roadmap for U.S. Robotics* [4].

Recent work in HRI has sought to address this challenge in a variety of ways, including haptic feedback [12], explicable task plans [7], verbalization of intentions in natural language [2] and the use of explicit and implicit adaptation mechanisms [11].

Virtual, augmented, and mixed reality provide additional methods for mediating human-robot interactions, enabling communication of intent by leveraging interaction space as a shared canvas for visual cues. Recent advances significantly enhance the feasibility and promise of this approach. Recently, for example, systems have been developed to visualize trajectories of mobile robots [3, 13, 15, 16], with results suggesting that humans prefer to interact with a robot when it presents its intentions directly as visual cues. But despite research in this area, most recent work presents passive,

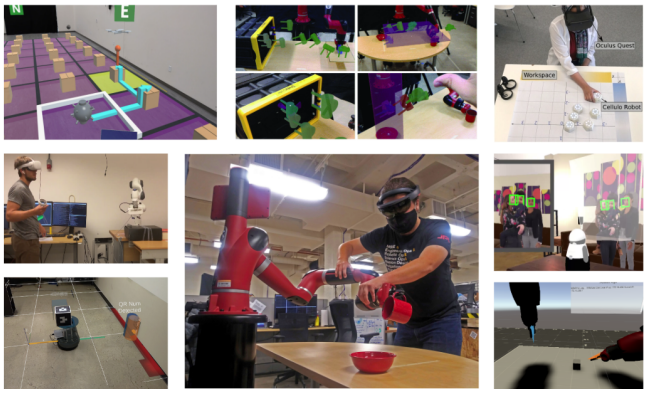

Figure 1: Recent advances in HRI using mixed reality technologies. From the first column (1) AR-based guidance for joint human-robot search [14]; (2) VR framework for mutual human-robot understanding [19]; (3) AR indicators for debugging robots [8]; (4, 5) interactive long-term robot skill maintenance [10]; (7) human-swarm interaction through VR [9]; (8) framework for Virtual Design Elements (VDEs) visualization of robot's signals [5]; (9) VR interface for robots manipulation [1] [Images used with authors' permission.

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non-interactive systems with limited scope. Moreover, these systems have not taken a true mixed reality perspective, as they have not considered the changing context of their environment while projecting information.

The growing field of VAM-HRI has given rise to new interdisciplinary opportunities and trends for researchers to investigate [6]. Experimental evaluation metrics, such as human comfort or user workload, have primarily been qualitative. New opportunities exist for developing and reporting quantitative metrics of interfaces and recording users' virtual data from experiments [6]. VAM-HRI research has also become more interdisciplinary and has recently explored how the field of visual computing and VR can help gather participant feedback for HRI [6].

Recent technological advances in augmented and virtual reality have allowed a wider scope of mixed reality environments allowing researchers to more meaningfully incorporate mixed reality in HRI [1, 5, 8–10, 14, 19–21]. Accordingly, this has led to an explosion of interest in this new research area, as evidenced by attendance at VAM-HRI 2018-22 (among the most attended workshops at HRI) and by the number of relevant papers presented at HRI 2018-22 and other top robotic conferences. In Figure 1 we illustrate some of the recent work in this area (including work from the organizing committee), demonstrating the growing potential and research interest in this.

VAM workshop focuses on technologies that can help diverse users connect with the robot in an immersive way, promoting important steps in making "HRI for all".

2 TARGET AUDIENCE

The 6^{th} International Workshop on Virtual, Augmented, and Mixed Reality for Human-Robot Interaction seeks to bring together researchers from across the HRI community to share and discuss work that develops interactive mixed-reality agents, uses virtual reality for developing interactive robots, designs novel mixed-reality interactions, and investigates how humans perceive such agents. The 1^{st} VAM-HRI Workshop [17, 18], held at HRI 2018, attracted more than 75 participants across academia, industry, and government from the Americas, Africa, Europe, Asia, and Oceania. For the 4^{th} and 5^{th} VAM-HRI, we adopted an online-only model, which increased the accessibility of the workshop and the number of participants to over a hundred participants. In adopting a hybrid-model, we hope to maintain the accessibility of the meeting online while encouraging in-person connections with physically present attendees. We expect a similar number of attendees in 2023.

3 TOPICS

The workshop welcomes contributions across a wide range of topics, including but not limited to *virtual/augmented/mixed reality* for: intention communication; behavior explanation; robot testing and diagnostics; HRI human-subject experimentation; Efficient data representations; language grounding; natural language generation; robot control and teleoperation; HRI Architectures; Computational modeling within HRI; expanding social interactions; ethical implications; and identification of novel HRI problems that can benefit from emerging VAM technologies.

4 FORMAT AND ACTIVITIES

While we encourage all participants to join the workshop in person, the organizing committee will prepare for the possibility of both in-person and hybrid conference formats. The VAM-HRI 2023 workshop will follow the common ground set by the previously held VAM-HRI workshops which spawned a persistent Slack group of VAM-HRI researchers. This Slack group contains the previous workshop papers, discussions, and software packages with plans to add the workshop attendees to the Slack workspace. The workshop will be composed of (1) an invited academic or industry keynote with Q&A; (2) panel discussions and/or breakout sessions; and (3) poster sessions and/or lightning talks from participants. Sessions can also be recorded to accommodate those who cannot attend live.

For a hybrid version of the workshop, remote participants will be able to participate via video conference. Any breakout sessions can be done among remote participants to encourage maximum engagement. The Slack workspace will also continue to provide a common discussion forum among remote and in-person participants. Each accepted paper will be given a Slack channel with links to the paper, poster, and breakout video conference link. Consequently, the authors will be able to interact with other participants online and in-person during the poster sessions.

Throughout the day, we are planning to have multiple VR and AR headsets with different demos available for the in-person participants, aiming to expose them to the technology that can be incorporated into their future research.

Tentative Workshop Schedule

9:00–9:15	Intro
9:15–10:00	Invited Talk
10:00–10:30	Lightning Talk Group 1
10:30–11:00	Coffee Break
11:00–12:00	Lightning Talk Group 2
12:00–12:30	Poster Session 1
12:30–1:30	Lunch Break
1:30–2:30	Panel
2:30–3:00	Lightning Talk Group 3
3:00–3:30	Coffee Break
3:30–4:30	Lightning Talk Group 4
4:30–5:00	Poster Session 2
5:00–5:45	Breakout Session
5:45–6:00	Wrapup
6:30–	Group happy hour and Dinner (in-person only)

5 PARTICIPANTS, SELECTION AND DOCUMENTATION

The call for submissions will be shared on relevant email lists and websites, including the workshop's dedicated site. We welcome 4-6 page papers on new work and 2-4 page extended abstracts (including references) on ongoing work. Each paper will receive at least two reviews. Accepted papers will be presented as posters and/or lightning talks and available on the workshop website.

Previous iterations of this workshop have utilized OpenReview, allowing submissions to be publicly available. Due to the virtual nature of the workshops, video archives of the event were also available on the workshop website. As was done for the 4^{th} VAM-HRI workshop [6], the organizers plan to write a paper on summarizing

lessons from the workshop, identifying trends of the subfield, and highlighting the emerging work in VAM-HRI.

6 ORGANIZING TEAM

Maciej K Wozniak is a Ph.D. student in the Robotics, Perception and Learning Division at KTH Royal Institute of Science supervised by Patric Jensfelt and Andre Pereira.

Bryce Ikeda is a Ph.D. student in the Computer Science Department at the University of North Carolina at Chapel Hill. He is a member of Interactive Robotics and Novel Technologies (IRON) Laboratory, led by Prof. Daniel J. Szafir.

Eric Rosen is a Ph.D. student in the Computer Science Department at Brown University. He does research in both the Humans To Robots (H2R) Laboratory and the Intelligent Robot Lab (IRL) He has previously served as an organizer of VAM-HRI 2020, 2021, & 2022.

Matthew B. Luebbers is a Ph.D. student in the Department of Computer Science at the University of Colorado Boulder, and a researcher in the Collaborative AI and Robotics (CAIRO) Lab, led by Prof. Bradley Hayes.

Michael Walker is a Ph.D. student in the Computer Science Department at the University of North Carolina at Chapel Hill. He is a member of both the Interactive Robotics and Novel Technologies (IRON) Laboratory, led by Prof. Daniel J. Szafir, and the Network for Exploration and Space Science (NESS) Team, led by Prof. Jack O. Burns. He has previously served as an organizer of VAM-HRI 2021 & 2022.

Christine T. Chang is a Ph.D. student in the Department of Computer Science at the University of Colorado Boulder. She is a member of the Collaborative AI and Robotics Laboratory led by Prof. Bradley Hayes. She is also a Draper Scholar and has previously served as an organizer of the VAM-HRI 2021 and 2022 workshops.

Thomas Groechel is a Ph.D. student in the Computer Science Department at USC as a member of the Interaction Lab, led by Prof. Maja J. Matarić. He has previously served as an organizer of VAM-HRI 2020, 2021, & 2022.

7 STEERING COMMITTEE

We acknowledge and appreciate Professors Tom Williams and Daniel Szafir's great work launching and overseeing this workshop for the last six years.

For VAM-HRI 2023, Steering Committee will continue to ensure the workshop's high standards and quality.

Andre Pereira is multidisciplinary researcher at the Division of Speech, Music and Hearing at KTH Royal Institute of Technology. His work focuses on Artificial Intelligence, Human-Robot Interaction, Extended Reality and Game Design. He creates autonomous embodied intelligent systems that can socially interact, in real-time, with humans throughout extended periods.

Jivko Sinapov is an Assistant Professor in the Computer Science Department at Tufts University and leads the Multimodal Learning, Interaction, and Perception Lab. The goal of the MuLIP lab is to enable robots to operate autonomously in human-inhabited environments through learning and interaction using multiple sensory modalities.

Stefanie Tellex is an associate professor in the Computer Science Department at Brown University at Humans To Robots Laboratory, focusing on three key challenges: perceiving the world using the robot's sensors; communicating with people to understand their needs and how to meet them; and acting to change the world in ways that meet people's needs. She has previously served as a steering committee member for VAM-HRI '22.

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