Beyond Glasses: Future Directions for XR Interactions within the Physical World

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Abstract

Recent developments in XR-related technologies enable us to extend the use of XR beyond laboratory settings and, therefore, beyond the common paradigm of head-mounted displays (HMD) or AR glasses. As the industry is pushing XR glasses to become the next-generation computer interface and mobile phone replacement, we see an opportunity to reconsider the future of XR interfaces beyond just this form factor and explore whether new affordances can be leveraged. In fact, while glasses represent the most convenient and practical wearable interface, users remain limited to a specific set of displays, raising concerns about privacy, social acceptability, and overreliance on the visual channel. Conversely, we believe that there is an opportunity to leverage the physicality of the world, including the human body and the surrounding space, to create more engaging XR experiences. In this workshop, our goal is to gather fresh insights and perspectives from HCI researchers, practitioners, and professionals on strategies and techniques to enhance interactions in XR beyond the conventional glasses framework. We will bring together experienced academics and emerging researchers within the interdisciplinary field of HCI. We anticipate developing research pathways to leverage physicality to investigate possibilities and obstacles beyond XR glasses, ultimately shaping a new approach to engaging with XR.

CCS Concepts

• **Human-centered computing** → **Interaction design**; **Interaction devices**; **Interaction techniques**; **Collaborative and social computing devices**.

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XR Interactions, Wearable and Ubiquitous Computing, Spatial Computing, Physical Interaction

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1 Motivation & Topic

In recent years, XR technologies have shown significant milestones in hardware performance advancement, such as display resolution, optical sensing accuracy, computing power, and battery efficiency [6, 13], while supporting various form factors from mobile [4] to glasses [8]. These advancements solved some key challenges of AR/VR development [2] and have formed a better pathway toward designing and prototyping XR experiences. As a result, HCI researchers deepen their research by going beyond laboratories to formulate prospective XR interaction design guidelines to strengthen performance and promote accessibility for enhanced user experiences.

To bring user experience forward, various attempts have been suggested to formulate theoretical support to provide design guidelines for using XR technologies [3]. Here, previous works have focused on defining common terms for XR, investigating the effectiveness and efficiency of utilizing XR, and examining human response to provided XR technologies. To this end, various applications have also been suggested following design guidelines in the areas of entertainment, education, healthcare, and training [1, 5]. Still, most of the works are geared toward applications that require the use of optical displays in either the form of head-mounted displays (HMD) or AR glasses. This leaves the users with no option but to equip or possess these devices regardless of preference or availability.

Figure 1: There exists lots of opportunities for future XR interactions to utilize the surrounding objects, human body, and physical spaces. These figures illustrate the prospective approaches to utilize the physical elements around the users to promote rich, immersive, and highly engaging XR interactions.

Currently, XR interfaces employ computer vision techniques to utilize the visual information about the user's body [9], nearby objects [7], and surrounding environments [11] to enable the concept of context-aware interaction. With the development of AI features, including large language models (LLM) and multimodal learning, the level of context awareness allows XR users to retrieve required information with ease and minimal effort. However, research using physicality from users/objects/environments is still early. Utilizing physical aspects such as proprioception of the body, natural tactile/force interaction with objects, and temperature/humidity/scent of ambient spaces, as well as the physical environment surrounding the users could unlock the possibility for us to interact more naturally with XR even beyond the glasses.

To foster the widespread adoption of XR in everyday life for the general population, this workshop aims to consider and explore potential ways to interact beyond glasses, which would be critical to convene within the HCI community. At this point, we need to start thinking about: 1) What interaction devices and techniques would allow us to move beyond the glasses? 2) How could we provide XR-based social interaction and collaboration anywhere and anytime? and 3) What type of physical interactions would be possible beyond the paradigm of AR glasses and how can we technically support these?

Throughout the workshop, we plan to encourage discussions among participants by introducing key themes and asking questions about how it might be possible to move beyond the glasses paradigm for future XR. To gather interesting insights and perspectives, we will reach out to various communities, including engineering, design, social sciences, natural sciences, arts, and humanities. We organized these questions into three themes to facilitate ideation and discussion to seek new opportunities and challenges for XR beyond the glasses.

1.1 Theme 1: What interaction devices and techniques would allow us to move beyond the glasses?

In this theme, we seek to discover new ideas and approaches regarding interaction devices and techniques. For interaction devices, we believe diverse form factors with various functionalities could be explored. On the other side, interaction techniques could focus on utilizing multimodal elements from interaction devices or information from XR interaction spaces. Topics can include:

- Interaction devices offering new user experiences in XR.
- Interaction techniques that enhance existing XR interactions utilizing either single/multimodal information.
- Interaction methods that exploit spatial-physical data for innovative and immersive interactions.

1.2 Theme 2: How could we provide XR-based social interaction and collaboration beyond the glasses?

Social interactions and collaborations are some of the key reasons for using XR [10, 12]. As more interactions become possible with recent AI features along with camera-equipped XR glasses, they start to raise concerns about privacy and personal information. Therefore, now is a critical time to discuss and explore fostering social interactions and collaborations beyond the glasses to respond to prospective harms. Topics can include:

- New methods of carrying out social interactions and remote collaborations that utilize physical elements.
- Approaches to managing the privacy and personal data concerns in XR glasses.
- Design guidelines and practices to foster social interactions and collaborations for utilizing physical elements.

1.3 Theme 3: How could we innovate the use of physicality to push our boundaries going beyond the paradigm of AR glasses?

The release of Apple Vision Pro and Meta Orion (XR glasses) has shown that XR devices are equipped with diverse hardware components, including cameras, displays, batteries, and touch sensors. However, it would be impossible to keep adding different sensors or actuators to the confined space of HMD or glasses. Thus, it is the right time to explore whether some of these functionalities, sensing capabilities, and visual/haptic displays could be replaced by the physical elements promoting interactions woven into the real world. The topics can include:

- New methods to utilize physical interaction space to replace or supersede XR glasses functionality.
- New approaches to enhance existing XR glasses functionality using physical elements.
- Design ideas for utilizing the human body, objects, or environments as interaction mediums for XR.

2 Pre-Workshop Plans

2.1 Target Audience & Recruitment

The organizers have been communicating via teleconference, email, and messaging regularly over the last few months to develop a plan and coordinate their efforts for this submission. We will have regular teleconference meetings to finalize the workshop agenda, deliverables, and activities.

Before the workshop, we will distribute a call for position papers through the workshop website, social media, mailing lists, and other public websites. We will send targeted email invitations to researchers in our own networks and to leading researchers across different academic institutions, inviting them to participate and distribute the announcement within their organizations. Our website hosts the call for participation, information about the workshop's organizers, announcements, and paper submission instructions. We are currently preparing a list of potential attendees from both academia and the industry. We already have support from a government research grant to support a portion of the workshop cost. We plan to continue promoting our workshop and getting in touch with potential contributors until the submission deadline. We are planning for around 25-35 attendees.

2.2 Paper Submission & Review Process

The submission for this workshop will take the form of a short position paper (up to 4 pages) or demo paper (up to 2 pages with video) addressing one of the themes from the workshop using the publication version of the ACM Master Article Template (https://chi2025.acm.org/chi-publication-formats). The accepted position papers will be presented in a paper session, and demo papers will be presented as interactive demos. For this workshop, we are more interested in ongoing work rather than completed or presented works.

The position paper submissions will be managed on the HotCRP platform. We will also collect the interest for participation through Google Forms along with paper submissions for prospective attendees. Following submission, the papers will be distributed among organizers to find at least two reviewers for each submission. Reviews will be based on quality and relevance to the workshop's themes. The organizers will gather the overall reviews and meet to finalize the accepted submissions. Then, successful submissions will be invited to the workshop, and we will collect accessibility information for prospective participants.

3 Workshop Structure

Due to the nature of interactive demos and in-person design activities, the workshop is planned as a one-day in-person event (9:00 am to 5:20 pm). We will have demo assistants to support the interactive demo session setting and organization.

We plan a series of activities, starting with an icebreaking session where participants get to know each other and learn about others' interests and research backgrounds. Then, an enlightening keynote talk will address current opportunities and challenges, followed by a moderated large group discussion and bottom-up synthesis. We will encourage (for position papers) and require (for demo papers) participants to bring demos to showcase their research works to promote interactive discussions among participants. The workshop will be divided into four activities.

3.1 Activity 1: Introduction and Ice-breaking

After a short introductory session in which the organizers introduce themselves and present an overview of the schedule for the day (about 10 minutes), we will conduct a fast turnaround introductory presentation for each participant (<1 min) where all participants can freely share their interests and research background through shared slides for 30 minutes. The main objective for this preliminary session is to have all participants familiar with each other's work, as well as to establish a supportive and friendly atmosphere that will provide a natural transition to the subsequent activities.

3.2 Activity 2: Keynote & Discussion

For the second activity, we will start with a keynote from an HCI professional whose expertise is in XR interactions with the physical world. We expect about 45 minutes of talk followed by a coffee break for the continued discussion and Q&A.

3.3 Activity 3: Paper Presentations

After a morning coffee break, we will move on to the paper session. Here, the authors with accepted papers will present their position papers. The length of the presentation will be determined based on the number of accepted papers. We will spend 1 hour and wrap up with lunch site recommendations.

3.4 Activity 4: Interactive Demo/Video Presentation

For the start of the afternoon session, we will move on to the interactive demo/video session. Here, we will start with a spotlight (<30 seconds) for each author to pitch their demo papers to the participants to foster smooth interaction throughout the session. After the spotlight pitch (which should take less than 10 minutes),

we will spend about 80 minutes. In this session, we plan to provide simultaneous coffee breaks to encourage more social and free environments during the demo sessions.

3.5 Activity 5: Guided Analytical Small-group Ideation & Discussion

For the start of the afternoon session, co-organizers will initiate a debate with the audience about exploring potential examples of each theme: new interactions and devices beyond the glasses, ways to promote social interaction and collaboration anywhere and anytime, and methods of utilizing physicality for XR. For that, the audience will split into small groups of 3-5 people and be asked to discuss specific topics that emerge from both the accepted position papers and the talk. We will start by asking each group what hypothetical project they would initiate if they could simply combine their current interests and projects they currently have underway. Activity 5 will last for 50 minutes.

3.6 Activity 6: Larger-group Discussions and Synthesis & Conclusion

The final activity of the workshop will be based on larger-group discussions, moderated by other co-organizers. Based on the previous group discussion, we will form a bigger new group by combining multiple teams with common interests. This time, the discussion will be centered around synthesizing the major technological trends and approaches discussed during the day. We will provide post-its and sketch papers for each group to visualize and organize the main ideas of going beyond glasses within the physical world. Based on audience preference, we will provide paper, whiteboards, and/or walls for the presentation.

Then, we will finalize the session with short presentations from each group to share their thoughts and opinions, and co-organizers will moderate this process. At the end of the day, we expect audiences to take away fresh ideas about utilizing emerging technology and methodology for future XR interactions within the physical world while identifying new areas of common interest.

4 Post-Workshop Plans

We will close with a wrap-up discussion that reflects on the day's conversations and activities, focusing on how to harness these conversations and design provocations to maintain momentum for prospective research. The results from the workshop will be distilled and shared with the HCI community via a position article (e.g., ACM Interactions, IEEE Consumer Electronics Magazine) that will capture the current trends and what we expect to be the next direction of XR interactions. We will also encourage the workshop participants to submit a paper independently, either as an extension of their position paper or as a possible collaboration with other workshop participants.

To keep the communication going forward, we will formulate platforms for the event: 1) we will reach back to the participants a few months after the workshop, asking them to share through survey or email any updates on their research; 2) we will start planning a new edition of this workshop at other premier conference venues; 3) we plan to open the Discord group channel to share the accepted position papers, presentation materials, demo videos/photos, and any open calls for the formal paper submission which we hope will foster a sense of community among the diverse researchers and practitioners interested in our vision.

5 Organizers

To gather many different perspectives about the topic of this workshop, we formed a group of broad international organizers, including established and junior researchers interested in HCI, accessibility, haptics, sensing techniques, and XR. With the proposed team of organizers, we will establish constructive and prospective research activities throughout the workshop.

Sang Ho Yoon is an Associate Professor in the Graduate School of Culture Technology and an Adjunct Professor in the School of Computing at KAIST. His research has focused on promoting natural interactions by enabling novel sensing techniques and haptic experiences with the aid of applied machine learning for next-generation XR interfaces. In particular, he has developed a keen interest in developing sensing and haptic interactions for immersive and inclusive experiences. Sang Ho organized the International Workshop on XR Solutions for Smart Production (2024) and several domestic academic HCI workshops.

Andrea Bianchi is an Associate Professor in the Department of Industrial Design and an Adjunct Professor in the School of Computing at KAIST. He researches in the field of Human-Computer Interaction, focusing on building tools for prototyping and physical computing, as well as hardware systems for body augmentation (haptics, XR, robotics).

Hasti Seifi is an Assistant Professor in the School of Computing and Augmented Intelligence at Arizona State University. Her research focuses on haptics, robotics, and the accessibility of visual media. She has helped create open-source datasets and interactive tools for XR and haptics, and has co-organized workshops at ACM CHI, IEEE VR, and IEEE World Haptics.

Radu-Daniel Vatavu is a Professor of Computer Science at the University of Suceava, where he directs the Machine Intelligence and Information Visualization Research Lab. His research spans topics from HCI, Ambient Intelligence, XR, and Accessible Computing. In this space, he has focused prioritarily on enabling efficient interactions with computer systems from large displays to personal mobile and wearable devices to hybrid environments, which exploit both natural and non-natural interaction modalities. He is also interested in making computing more accessible, and his work has often addressed interaction design for users with visual or motor impairments. He was Papers Chair for ACM TVX (2019) and ACM EICS (2019), and has been acting as Associate Chair for all the major HCI and XR venues.

Jin Ryong Kim is an Assistant Professor in the Department of Computer Science at the University of Texas at Dallas. His research focuses on Human-Computer Interaction, haptics, and XR. He is particularly interested in developing novel haptic interfaces and multisensory systems for immersive virtual environments. His work spans areas such as tactile feedback, thermal perception, and the integration of these sensations to create more natural and intuitive user experiences in XR applications.

Table 1: Questionnaires and Objectives Employed in User Study Session 1

Time	Activity
9:00-10:00	**Introduction & Ice breaking.** Organizers will present the workshop goals and topics, and give an overview of the workshop details. Participants will then present brief ice-breakers based on the pre-workshop survey.
10:00-10:45	**Keynote Talk.** One 45 minutes keynote by an HCI professional with expertise in XR interactions followed by 15 minutes of Q&A.
10:45-11:00	**Morning Coffee Break.**
11:00-12:00	**Paper Presentations.** We will start this session with paper presentations from each author of recommended position papers.
12:00-14:00	**Lunch.** We will suggest some key lunch places to ensure a group of people continues the discussion throughout the lunch as well.
14:00-15:30	**Interactive Demo/Video Session including Coffee Break.** We will start this session with spotlight (<30 seconds) presentation from each author of recommended demo papers. The interactive demo and video presentations will follow right after the spotlight presentations. The coffee break will be provided simultaneously to provide more opportunities for presenters to interact with participants in social environments.
15:30-16:20	**Small Group Design Activity.** Organizers provide detailed objective goals for the design activity. Each team works in a small group to develop and formulate design ideas related to workshop themes with the choice of using any presentation method (shared document, graphical representation, etc.).
16:20-17:00	**Larger Group Design Activity & Discussion.** Organizers will combine multiple teams to form a larger group to synthesize various ideas. After another round of design activity, each group will pitch new ideas to the whole workshop audience, followed by short Q&As.
17:00-17:20	**Research Agenda Activity & Wrap-up.** Organizers will reflect on the workshop, and the follow-on research agenda activity will be discussed among participants.

Jeongmi Lee is an Associate Professor in the Graduate School of Culture Technology at KAIST. Her research lies at the intersection of cognitive neuroscience and HCI, aiming to understand the mechanisms of how people process information in novel (e.g., XR, game, etc.) media environments. She focuses on investigating the principles of the cognitive processes for multisensory content in XR and utilizing the principles to devise methods to enhance users' experience and performance.

Geehyuk Lee is a Professor in the School of Computing at the KAIST. His primary research interests are interaction devices and techniques for smart information appliances, wearable computers, and smart environments. He is currently directing the XR Workstation Research Center at KAIST, which focuses on HCI technologies to make XR a practical platform for everyday productivity applications.

6 Call for Participation

We invite researchers and practitioners to submit to our upcoming workshop, "Beyond Glasses: Future Directions for XR Interactions within the Physical World." As XR glasses become affordable, it is time to seek opportunities beyond the glasses. This workshop aims to gather the HCI community to discuss novel ideas that leverage the physical aspects of everyday interactions, utilizing modalities beyond the visual channel to enhance XR experiences.

The workshop will be a 1-day (9:00 AM to 5:20 PM) in-person event. We expect between 25 to 35 participants. We plan a series of activities to learn about each other's work and interests, present ideas, and work in small teams for moderated discussions.

Participants will be selected based on the relevance of their submissions to the workshop themes. We welcome position papers of up to 4 pages or demo papers of up to 2 pages (excluding references) using the CHI 2025 publication formats (https://chi2025.acm.org/chi-publication-formats). Appropriate topics include, but are not limited to:

- New interaction devices and techniques beyond the glasses: Exploring devices and methods that enable XR interactions without relying on HMDs or AR glasses.
- XR-based social interaction and collaboration beyond the glasses: Investigating approaches to facilitate social interactions and collaborations respond to prospective harms.
- Physical interactions beyond the paradigm of AR glasses: Design ideas to utilize physical elements as interaction mediums for XR.

Join us in shaping the future of XR interactions beyond glasses and contribute to this exciting discourse within the HCI community.

6.1 Additional instructions to appear in the CFP on the workshop's website

Please submit your position (up to 4 pages) or demo papers (up to 2 pages with video) via HotCRP by [submission deadline]. Accepted papers will be presented as papers or interactive demos during the workshop. At least one author of each accepted submission must attend the workshop, and all participants are required to register for both the workshop and the main conference. For more information on submission guidelines, important dates, and workshop details, please visit our website or contact sangho@kaist.ac.kr.

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