Novel Interaction Techniques for Collaboration in VR

Abstract
Following their introduction in the 1960s, head-mounted VR systems mainly focused on visual and aural senses. In order to enhance immersion in the virtual world, researchers have since pursued the addition of movement and haptics through motion platforms, exoskeletons, and other handheld devices. From a proliferation of low-cost devices that can sense the user's motion to full body motion capture suits, from gloves to gestures, natural interaction techniques have been desirable and explored in HCI and VR for several years. With virtual reality rapidly becoming accessible to mass audiences, there is growing interest in new forms of natural input techniques to enhance immersion and engagement in multiuser systems. First we need to determine what types of techniques can we design that would integrate well with multiuser experiences. Next, we need to understand the contribution of the designed techniques to the experience, understand how they work with existing controllers, and explore whether they should replace or augment current techniques in order to design more effective and engaging experiences. Finally, it is vital to discern the limitations and the types of application scenarios that are suitable for incorporating the techniques. The aim of this workshop is to deepen and expand the discussion on natural interaction techniques for collaborative VR within the CHI community and promote their relevance and research in HCI.
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Background
Virtual reality, once the material of science fiction, has recently become available to consumers. Plunging users into a 3D world and letting them explore as if they were really there, VR is a medium that can transcend the bounds of physical reality by transforming a user's sense of place [8]. A user is immersed in VR in two ways: first, through the computer generated surroundings, and second, through a match between proprioceptive signals about the movements of their body with those of a corresponding virtual body [9]. Presence or the user's sense of 'being there' can be enhanced by integrating natural interaction techniques into the virtual experience. For example, using real walking for locomotion or using hand gestures for interaction with objects in the virtual environment. However, currently available consumer VR applications most entirely rely on hand-held controllers or keyboards for interaction.

Interaction fidelity is the degree to which physical actions used for a virtual task correspond to those used for a similar real-world task [1]. On the high end are realistic interactions which are useful for training applications as they mimic the real world interaction closely. On the other end of the spectrum are the non-realistic interactions that have no relationship to reality, for e.g., pushing a button to shoot lasers from the eyes. Somewhere in the middle are magical interactions [3] where users make natural physical movements but gain new and enhanced virtual abilities [1]. Examples include, swinging arms to move, breathing out fire, or grabbing objects from afar [7]. Using passive haptics, participants can interact with virtual objects through their physical proxies in Metaspace II [14]. These hyper-natural interactions aim to enhance the user experience by reducing interaction fidelity and overcoming the limitations of the real world [3]. This workshop aims to explore the design space of hyper-natural interactions that can enhance a user's experience while understanding the challenges and limitations for their use in various types of applications.

With the introduction of each new communication technology, it has seemed like we have always been on the verge of a utopian environment where distance disappears and we interact as richly with those around the world as we do with those in the same room [2] and so it is for VR. Collaborative virtual environments (CVEs) represent a natural extension of singleuser VR that can recreate the experience of being face-to-face with another person, regardless of whether people are co-located or geographically distributed. With growing demand for multiuser VR, asymmetrical experiences are beginning to emerge that allow collaboration between VR and non-VR users. For example, Keep Talking and Nobody Explodes is a cooperative game for 1 VR and 1 PC player and Mass Exodus is a local and online game for 1 VR vs up to 4 PC players. Despite the technical advances, the development of natural interaction interfaces for VR is still in its infancy and much work will be required in order to create systems that are meaningful to users and at the same time scalable.

It is increasingly evident that the design of interactive systems can change focus on tasks and functions to a perspective of creating meaning. Immersive collaborative experiences involving natural interaction techniques are still not fully explored. That said, technology is advancing and...
we can see some design examples start to appear. SnowballVR is an asymmetrical two-player game where each user plays a role that is defined by the size of their physical space allowing for seated or standing users to play with room-scale users without curtailing their experience due to limited tracked space. Interaction between participants happens through modified Nerf guns that shoot out virtual snowballs [12]. Metaspace I allows co-located users with full body tracked avatars to interact naturally with one another while free to walk around in the physical space and use speech for communication [13]. Oasis provides a room-scale experience to geographically distributed users by automatically creating a combined virtual space such that participants are free to walk and interact naturally [11]. Social VR applications like Facebook Spaces allow people from around the world to meet in VR while sitting at their computer in the real world while VR entertainment centers (The VOID, VRcade Arena, Zero Latency) provide warehouse-scale VR experiences to multiple users simultaneously, and allow for natural walking to navigate the virtual environment. As is evident in the examples cited above, we do not limit the design scenarios to common collaborative tasks such as puzzle solving or model building and include tasks that use room-scale movements or require body movements. We also consider tasks like attending a lecture or viewing data visualizations together where multiple users are simply present in the same virtual space looking at the same thing together [6] as collaborative. With this broader and more inclusive scope, we hope to invite larger participation where researchers explore a variety of scenarios in which users can work, play, learn or create together.

There are opportunities to enhance the scope of interaction techniques for both designers and developers in terms of their ability to create meaningful interactions and adapt the whole spectrum of interactions in the real world. FLOCK is a shared co-located immersive experience for up to 30 users who are free to move around in an tracked physical space and receive visual and auditory feedback [4]. With the goal to steer the direction of social VR towards positive activities as opposed to war games, HOLO-DOODLE allows participants to paint together in VR [5]. HOLOJAM IN WONDERLAND, a theater piece performed at the 2017 Future of Storytelling Festival in which all actors and audience members within the same physical room share an untethered VR experience, explores the opportunities for magical realism when live theater is performed within collocated VR.

Slater et al.[10] assert that CVEs do not necessarily need to reflect or embody all the characteristics of conventional environments to enable them to support particular forms of activity or interaction. Combined with magical interactions, that are neither realistic nor entirely non-realistic, even with limited properties of worldliness represented or embodied in CVEs can create engaging and effective experiences. Research of this kind could prove useful for designers and developers to meaningfully harness natural behaviors for interaction which can open up a new ways of experiencing VR and in turn, new applications. Terms and descriptions such as “It felt natural,” “It’s obvious,” make it difficult to extract the underlying properties of the specific experience.
and consequently inaccessible to designers. Therefore having a framework that can categorize descriptors can lead to the creation of an actionable vocabulary for designers and evoke discussions around interaction design, especially as we start looking at similar experiences but vastly different descriptors across cultures.

Furthermore, it is crucial to determine the meaningful design space for interactive collaborative experiences. At the same time, it is key to understand the unique properties and limitations of a technique before integration in the design of interactive systems. Studying natural interaction not only enhances the design space of collaborative VR but also helps to improve the fundamental understanding of how realistic do the interactions need to be or to even design new interaction paradigms that feel natural and are easily learnable, similar to pinch and zoom gestures on smartphones.

**Workshop Aims**

This workshop will draw together an international and interdisciplinary group of researchers, designers, and developers from academia and industry to collaborate and explore the opportunities around the design of new interaction techniques for collaboration in VR. We will challenge current interaction paradigms, mainly based on hand-held controllers, gloves or keyboards and explore other design spaces and map future trajectories for interaction techniques. More specifically, this workshop will focus on three grand challenges in multiuser VR experience research:

- Discuss what the goals, limitations and challenges of designing new interactions techniques are.
- Explore different ways of how to design interaction techniques for multiuser VR experiences.
- Capture meaningful collaborative contexts and interaction scenarios for interaction.

This workshop is re-defining the beginning for a new generation of research endeavors in VR interaction, which has had a long history. We plan to incorporate lessons from other domains in HCI, especially 3D interactions, psychology and the human perceptual system. We also hope to impact other disciplines such as social psychology and related areas – how multiuser VR can be used to throw light on some social phenomena, and how it can be used to tackle experimentally areas that cannot be studied experimentally in real life.

**Organizers**

Below we provide short biographies on each workshop organizer. Expertise and interests are complementary and reflect the interdisciplinary perspectives on the workshop topic. The workshop organizers are all active researchers in the area of collaborative multiuser virtual reality, focusing on both novel interaction techniques and communicative elements of interaction. Collectively, the organizers have considerable experience organizing workshops on related topics.

Misha Sra is the main contact person.

**Misha Sra** is a PhD candidate at the MIT Media Lab. Her work focuses on the design of multiuser room-scale VR experiences that examine the implications of space in co-located or remotely located scenarios and the design of asymmetrical VR + PC experiences. Her inspiration comes from the paragons of virtual reality like the Holodeck from Star Trek or William Gibson’s cyberspace. She is looking forward to a VR future with Sword Art Online’s NerveGear or Ernest Cline’s robotic arms and doing her part to help build it.

**Ken Perlin** is a professor in the Department of Computer Science at New York University, where he directs the Future
Reality Lab. His research interests include socially shared virtual and augmented reality, computer graphics and animation, user interfaces and education. He is hoping to help build a better world where our computer-augmented interactions will be more like Harry Potter meets Harold and the Purple Crayon.

Luiz Velho is a Full Researcher at IMPA and the leading scientist of VISGRAF Laboratory. His work spans a wide range of topics, including modeling, visualization, imaging, animation and interactive techniques. In particular, he has developed over the last 20 years, VR platforms for 360 degrees gigapixel panoramas, as well as, interactive horizontal stereoscopic display systems. More recently, he has been actively investigating authoring aspects of multi-player in-situ VR experiences.

Mark Bolas is a Director at Microsoft where he guides incubation and user experience of their Mixed Reality products. His work broadly considers perceptual media that augment perception, intelligence, and, ultimately, personal agency, which are the basis for his specialization in body-based human-computer interfaces and mixed reality. His goal is to positively shape the increasingly virtual world and ecosystem as one that is joyful and humane, where aesthetics and narrative intertwine with body and emotion to create engaging interfaces that deliver a sense of satisfaction and meaning.

Website
The workshop website will promote the workshop theme, engage a broader audience in discussions, and facilitate submissions of position papers. The website is available here: https://virtualreality-chi2018.media.mit.edu

Pre-workshop Plans
The workshop’s Call for Participation will be distributed via mailing lists (e.g., ACM SIGCHI, ACM Multimedia), social media (e.g., Women in VR group on Facebook), and through direct emails to faculty and graduate students at research institutions to encourage researchers in the field of HCI, VR and interaction to participate. We will use the workshop website to promote submissions to the workshop and will later be used for networking and further community building. The website will serve as a reference point for researchers, designers, practitioners and interested audience in exploring novel interaction techniques for VR. We will provide a section on readings that we would expect the participants to do before attending the workshop in order to prepare for the brainstorming and prototyping sessions.

Workshop Structure
The one-day workshop will start with a brief history of interaction techniques and collaborative VR followed by an overview of current challenges and limitations.

• 9:00-9:10: Welcome by the organizers.
• 9:10-9:30: Introductions: each attendee will introduce themselves to those sitting around them and on a card describe their interaction in three words. At the end, all cards will be collected on a whiteboard or wall and categorized by common interaction techniques.
• 9:30-10:00: Talks on “Simulating Future Reality” by Ken Perlin (NYU) and “Playful Interaction Techniques in VR” by Misha Sra (MIT Media Lab).
• 10:00-10:30: Clustered overview on the different perspectives from the accepted position papers. Each participant will have 3 minutes to present the “main idea” of their paper and they will be free to use any
medium of their choice that best conveys their ideas (slides, demo, enactment etc.).

• 10:30-10:45 Coffee break

• 10:45-11:30: Participants will be divided into groups of 3 to 4. Each group will brainstorm solutions for a VR scenario given by the organizers (e.g., design an interaction mechanism for a two-player game underwater). There will be at least one organizer at each table as facilitator.

• 11:30-12:30: Each group will have 8 minutes to present their idea followed by 7 minutes for questions and discussion (assuming 6 groups in total).

• 12:30-13:30 Lunch (organizers will arrange a lunch outing for the workshop participants)

• 13:30-14:00: Talks on "Interaction and Narrative" by Luiz Velho (IMPA) and "Instinctual Interaction" by Mark Bolas.

• 14:00-14:30: Open discussion on how and if VR and related technologies can be used for studying/understanding/solving challenges related to energy, medicine, food, cities, brains, wellbeing, race, sex/gender, aging, entertainment, design, and more. The organizers would like to take notes during this session and make them available on the workshop website.

• 14:30-15:00: Individual brainstorming session (10 minutes) on exploring and finding the most interesting and compelling things to prototype (for some this may be inspired by Science Fiction), to answer the question “What have you always wanted to see become real?” Then we will build groups of 3 to 4 people, and each person will present their idea to the group. The group will choose one idea for further discussion and elaboration.

• 15:00-15:30 Coffee break

• 15:30-16:30: Each group will sketch a "napkin prototype" (on paper, in Legos, with clay, Sculpey, Foam, Arduino, Processing, etc.), on interaction inspired by their favorite Science Fiction (or other) storyworld, character or artifact (30 minutes). The organizers will provide the prototyping materials.

• 16:30-16:50: Each group will present their idea and will have a maximum of 3 minutes to do so. They will need to explain what it is, what it does, how it works, and how it could be done today, i.e., what parts and processing exist today that would allow you to make it. Everyone will vote and at the end of the presentations, we will announce the winning group.

• 16:50-17:00: Wrap up on what the future might look like for novel interaction techniques for collaboration in VR, actions for follow-up activities (summary report to be published on the website, and ACM Interactions contribution).

• After 17:00: After workshop ends, informal discussion and brainstorming will continue during drinks and dinner.

To facilitate the workshop activities we would require the following resources:

• Flipchart boards for 6 groups
• Large wall that can be filled with post-it notes
• Movable furniture for flexible table arrangement
Call for Participation
We invite papers for the CHI 2018 Workshop on “Novel Interaction Techniques for Collaboration in VR.” This one-day workshop will offer an interdisciplinary forum of discussion for both academics and practitioners, designers and developers, interested in research on interaction techniques in VR beyond the controller or keyboard.

This workshop focuses on three main challenges of novel interaction techniques for collaboration in VR:

• Understanding the goals and limitations of interaction techniques in multiuser VR environments.
• Exploring different designs of new interaction techniques that replace or augment existing techniques.
• Capturing meaningful collaboration contexts and interaction scenarios for using the designed techniques.

We invite researchers from both academia and industry with an interest in new interaction techniques to submit a position paper. The position paper should be at most four pages in the CHI Extended Abstracts format. This paper should address one or more of the workshop’s main areas listed above. All submissions will be reviewed based on the three areas by the workshop organizers. Demos are encouraged and will get space in the workshop agenda.

Participants will be selected on the basis of the quality of their position paper. At least one author of each accepted paper must register for the workshop and for one day of the CHI conference. Participants will be invited to present their paper at the workshop and will actively engage in a lively discourse on the design space of interaction techniques for collaboration in VR.

Please submit your position paper via the Precision Conference System. You can find the link and details for the submission on our workshop website: http://virtualreality-chi2018.media.mit.edu

Important dates:
• Submission date: 15-Jan-2018
• Notification date: 20-Feb 2018

Post-workshop Plans
All accepted submissions to the workshop will be made public on the website. Authors of the submissions will be invited to send updates on follow-up-studies related to the workshop submissions. In accordance with the authors, these updates will also be published on the website. Furthermore, the outcome of the workshop will be submitted as a summary report to ACM Interactions to reach out to a larger community of academics and practitioners interested in new frontier research in VR.

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