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### Title

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### Permalink

<https://escholarship.org/uc/item/26q142pp>

### Journal

International Conference on GIScience Short Paper Proceedings, 1(1)

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### Publication Date

2016

### DOI

10.21433/B31126q142pp

Peer reviewed

# Spatially situating remote users: An examination of immersive technology on presence and team participation

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## Abstract

As today's workforce becomes more distributed, technology provides a means to communicate over long distances. This technology however offers limited forms of communication which can lead remote participants to not feel fully participant in collaborative efforts. With the renewed interest in immersive virtual reality (iVR) technology, the promise of more affordable and better capabilities is better than ever. iVR technology can allow remote collaborators to become spatially situated in the content of a collaboration. For this work-in-progress we examine levels of immersion to understand the role of co-presence for a remote participant on team membership and participation. Our experimental set up and preliminary results will be discussed.

## 1 Introduction

In today's workforce, technology has enabled communication and work to occur at a distance. Remote parties can easily join in meetings virtually through the use of various collaborative equipment. However, traditional audio and video technologies cannot create the full experience of being co-present in a meeting space with collaborators.

With the increased capabilities, affordability, and renewed interest in immersive virtual reality (iVR) technology, the potential to spatially situate remote parties into a meeting is higher than ever. iVR technology has been a communication tool for several decades, but recent breakthroughs make the hardware and software to create iVR experiences easier to use than ever before. Past research using iVR systems have examined their ability of spatially situating individuals into task spaces with great success. However, these studies have examined such technology through the limited scope of testing a single system. This 'black-box' approach to VR systems research is a limiting factor in the literature. We believe that comparing multiple iVR system aspects will allow for better connections to spatial experiences that will be generalizable to a broader scope of technology.

We used our work-in-progress to address the question of how spatially present a remote collaborator feels when experiencing different levels of visual immersiveness. Specifically, this study seeks to examine the relative impact of different levels of immersive technology on spatial co-presence in a meeting with one remote participant. To do this, our study built on the theoretical framework and methodological approach of Balakrishnan, Oprean, Martin, and Smith (2012) to identify levels of immersiveness. Our methodological approach allowed us to address our question through examining technology affordances—the attributes of technology that allow for actions or perceptions of actions by the appropriate entity (Greeno 1994).

### 1.1 Presence and Immersion

The nature of presence, the feeling of being 'present' within a given medium (Steuer 1992), in and of itself is highly subjective, making it hard to distinguish from concepts like immersion,

an objective measure of a medium providing sensory engagement (Slater 1999). Our focus was on a theoretical framework forming sense of presence in various forms (spatial and co-) through more engaging, ‘immersive’, technology.

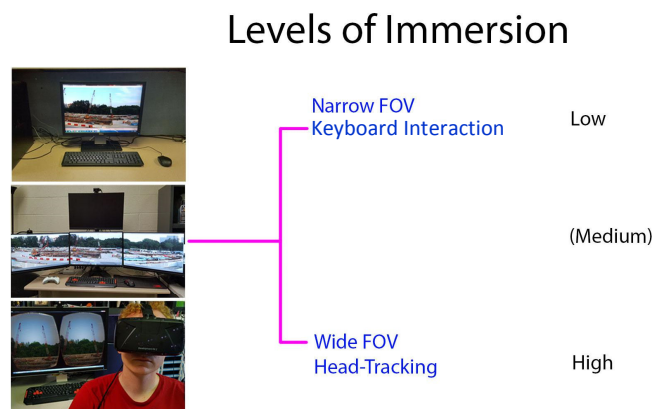
We focused on co-presence, which should be distinguished from *telepresence*. Whereas telepresence can occur without others involvement, co-presence depends on having another human to connect with through a communication medium (Nowak and Biocca 2003), a human-human relation (Zhao 2003). The sense of presence felt by a remote participant may have implications for their participation in team activities. Sense of presence has been proven to be impacted by immersive capabilities of technology, specifically iVR technology (Balakrishnan and Sundar 2011).

## 1.2 Exploration of Technology to Spatially Situate Users

Social co-presence is important, but we believe there are other influences on a user’s sense of participation, particularly when it comes to real-world team problems like distant field sites. By contextually placing remote participants into spaces through more immersive technology, we sought to engage the user’s senses, motivating them to become more involved. We built off the education domain’s use of situated learning, where virtual environments (VE) spatially situate learners (Wilson and Myers 2000). Learning through a VE raises two challenges: teaching users how to communicate with a medium and teaching users the content presented. This two-step process applies to collaborative systems in distributed workforces as well as education (Robey *et al.* 2000). As technology becomes easier to use, we believe that features meant to engage while reducing difficulty in use will enable remote collaborators to communicate better.

## 2 Methods

To address our overall inquiry, we aligned our selected technology on a spectrum where we considered each of the attributes for comparison as conceptualized variables. This process followed the adapted variable-centered approach utilized by Balakrishnan and Sundar (2011) to look at technology affordances. Immersion as distinguished by Slater (1999) is the objective output of the technology engaging a user’s senses. Bowman and McMahan (2007) additionally used a taxonomy of display attributes for virtual technology. Through the adapted variable-centered approach, we applied this taxonomy across different display technology. Specifically, we aimed to address and incrementally measure aspects of visual immersion on co-presence and team membership, allowing for results that are more generalizable across a broader scope of iVR technology.



**Figure 1. Three levels of immersion (single-screen, multi-screen, Oculus Rift).**

For this work-in-progress, we looked at the relative impacts of Field of View (FOV) and basic changing viewpoint interaction, classified as “passive” input (Bowman, Kruijff, LaViola, and Poupyrev 2005: 89). To represent these technology affordances, we used three setups (Figure 1): 1) standard desktop (narrowest FOV and keyboard interaction), 2) multi-screen desktop (wider FOV and keyboard interaction), and 3) Oculus Rift (wider FOV and head-tracking interaction). The same content was provided using a 360° camera (Ricoh Theta S) to help remove any influence of video quality.

We used a (3x2) experimental design with three levels of immersiveness examined across two environments: 1) conference room and 2) outdoor ‘field site’. As presence was a subjective measure, we adapted items of spatial presence (Vorderer *et al.* 2004) and co-presence (Slater, Sadagic, Usoh, and Schroeder 2000). Additionally, we looked at team membership and participation through items for team virtuality (Schweitzer and Duxbury 2010) and coding of communication (Gabriel and Maher 2002).

Our collaboration setup used two students with a semi-scripted discussion on placing recycling bins outside of a building on a university campus. The collaboration utilized a combination of a turn-based decision-making with open discussion to attempt to reach consensus. The study site, Figure 2, remained the same for all conditions.



**Figure 2. Site for the Collaboration on recycling bin placement.**

The collaborators were positioned either in a conference room with PowerPoint photos or outside of the building at the location being discussed. The setup for each location consisted of the Ricoh Theta S, spherical 360° camera, and a phone running Skype for audio over WiFi, Figure 3. After consent was obtained, participants were randomly assigned to one of the three immersive conditions.



**Figure 3. Conference Room and Field Site Setup.**

### 3 Results

Our preliminary analysis looked at the relationship between presence measures based on which of the three immersive setups a user experienced. All of our survey items were tested and found reliable. A total of N=90 participants (45 male) from a northeast university acted as a remote third member of a collaboration. With further analysis, we aim to better inform the way remote

collaborators participate in meetings virtually, through an increased understanding of iVR technology solutions. The study will provide important insights into the benefits of currently hyped immersive VR technologies for developing a sense of presence that has the potential to improve both iVR applications and ecological validity of psychological experiments.

## Acknowledgements

The authors would like to acknowledge the generous support of the LMI Research Institute's Academic Partnership Program.

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