
GhostVR: Enhancing Co-Presence in Social Virtual Environments

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Abstract

Most people would never go alone into a museum. They go with a friend, with their partner or with a person sharing similar interests. In the real world, most spare time activities, including visiting exhibitions, watching games, going shopping or doing sports, are social experiences. Virtual reality (VR) for many spare time applications can therefore only succeed if it also enables social experiences. Hence, we are interested in how virtual multi-user experiences should be designed. In particular, we aim to support users in intuitively understanding the social context. In this position paper, we discuss research questions we aim to address, including missing information cues, disorientation, and proxemic challenges. We present a prototype that visualizes co-users and objects outside the user's field of view. The prototype highlights virtual objects co-users look at to foster conversation and shared experiences. We aim to spark discussions on designing VR that enables rich social experiences.

Author Keywords

Virtual Reality; Multi-User; Collaboration; Social VR.

ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: User Interfaces

Introduction & Background

After the recent Virtual Reality (VR) hype, VR now seems to be "heading into the 'trough of disillusionment'" ¹ [4]. To immediately start a new VR hype cycle, collaborative or Social VR has recently been released by several platforms and social media companies², hoping Social VR will become a killer app³. Moreover, VR is starting to be combined with Augmented Reality (AR), the technology announced to fulfill the hopes VR was promising, e.g., becoming more ubiquitous⁴. This combination is meant to rescue VR to completely fall into the 'trough of disillusionment' and to again envision how technology will change our life tomorrow. However, Social VR applications will face fundamental unsolved challenges. They will remain unsuccessful if they do not compensate for the *missing information cues* available in the physical world, prevent *disorientation*, and consider *proxemics*. In the following, we discuss three fundamental challenges for Social VR and highlight how our concept GhostVR addresses them. Afterwards, we briefly present the GhostVR prototype and show selected visualizations.

Missing information cues: Collaborative Virtual Environments (CVE) significantly differ from face-to-face situations as they require to use in- & output devices and interaction metaphors. Non-verbal cues used for an inter-social interaction are restricted compared to communication in the physical world [9]. Previous research looked into ways to compensate the lack of information sensed in VR [11, 16] as well as into dealing with the loss of spatial orientation when wearing VR glasses [7, 8]. Previous work also ex-

plored how to overcome the isolation of bystanders from VR users through using AR as bridging medium between VR and the physical world [2, 5, 12, 10, 17]. To realize successful Social VR experiences, it is necessary to provide more information cues to VR users than current approaches offer. In GhostVR, we aim to increase the sense of co-presence by informing users in VR about the social context around them, especially the context that is not visible in the reduced field of view current VR glasses provide.

Disorientation: Perception in VR differs from perception in the physical world resulting, for example, in distance underestimation and loss of spatial orientation [1]. Sra et al. investigate galvanic vestibular stimulation (GVS) during walking for collaborative navigation in a two-player virtual reality game. The work aims to direct the VR player through a non-VR player using GVS and to create unique immersive social experiences [13]. World-in-Miniature was proposed to increase spatial orientation in VR. Stoakley et al. use a shrunk copy of the virtual environment and enables users to move through the VR by moving one's own avatar through the shrunk copy. The approach enables fast far-distance movement and provides a good spatial orientation [14]. While previous work looked into improving the orientation of oneself in the virtual space, we aim to explore how to increase the orientation within the social context a user is virtually surrounded. GhostVR implements a set of techniques to increase the sense of co-presence, using sonic and visual cues.

Proxemics: When Social VR or AR users are co-located in the same physical environment, the physical space can get overcrowded. The intimate proxemic zone, described by Hall [6], can be interfered, and users might feel uncomfortable or even be unintentionally touched by co-users. Flock and HOLO-DOODLE are social VR spaces where many

¹Forbes: [The Hype Around Virtual Reality Is Fading](#)

²AltspaceVR, Facebook Spaces, Oculus Platform

³FastCompany: [How Facebook's Social VR Could Be The Killer App For Virtual Reality](#)

⁴The Economist: [The promise of augmented reality](#)



Figure 1: Views of the virtual museum used in our demo. The last two images show the visual cues to view the position of a co-user implemented in GhostVR – a frustum pointing at the co-user and an aura surrounding him/her.

users can share the same physical space [7, 8]. To avoid the collision of the users' physical bodies, Flock shrinks the users' avatars to small animals and extends the users' social bubble in the physical space by letting them wear feather wings they have to swing to move their avatars. Social VR for remote users can also create proxemic challenges. If users are remotely located, social VR creates the problem of variations in the physical size and shape of each user's space for mapping into a shared virtual space. Sra et al. propose an asymmetric approach to solve the spatial variation problem, by allowing people to choose roles based on the size of their space [12]. While proxemics between people and objects has been investigated in augmented exhibitions [15], the nature of proxemic zones of users, objects and co-users, is underexplored in the VR domain. We will use GhostVR to demonstrate several proxemic design challenges in a virtual environment to inspire a discussion about this topic.

GhostVR

We will present GhostVR (see Fig. 1), a prototype to foster interaction between co-users in CVE. GhostVR is a virtual museum application with a rich interaction design [3] that replicates an existing physical museum. It allows multiple users to explore the virtual museum together and to interact with its content. We provide auditory and visual cues to display co-users that are outside the user's field of view. Other users can be visualized by extending their avatar through an aura or using a frustum representing their field of view. By demonstrating GhostVR, we aim to spark discussions on interaction techniques for Social VR applications.

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