A Role Concept and Design Space for Social VR Application

Sylvia Rothe
LMU Munich
Munich, Germany
sylvia.rothe@ifi.lmu.de

Heinrich Hußmann
LMU Munich
Munich, Germany
hussmann@ifi.lmu.de

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Abstract
Virtual Reality has been increasing in popularity in the last years. However, viewers can feel isolated using head-mounted displays. Since the content of VR applications is often suitable for social experiences, it is important to know if the use of head-mounted displays is appropriate for enabling shared VR experiences and how non-HMD users can be involved. Even if viewers are in the same virtual environment simultaneously, they do not automatically see the same field of view, since they can freely choose the viewing direction. Our goal is to explore which components are needed and which values are available to efficiently support social VR experiences. We present and discuss a role concept and a design space for social VR application and highlight directions for future work.

Author Keywords
virtual reality; roles; design space; collaboration.

ACM Classification Keywords
H.5.1 Multimedia Information Systems: Artificial, augmented, and virtual realities

Introduction
In Virtual Reality (VR) the user utilizes head mounted displays (HMD) or other VR devices for inspecting the VR environment. Thus, the viewer can feel immersed and freely choose the viewing direction. The drawback of these systems is the associated visual and mental

separation from other people, i.e. social isolation. Natural discussion, like pointing on interesting objects in the VR environment or keeping the awareness about what others are focusing on, is impeded by the HMD. In this work, we analyze the different roles which the user can take in social VR experiences. We identify key properties and related design aspects that are important for efficiently supporting social awareness and interaction in shared VR experiences. A design space for social VR experiences is presented, which describes essential dimensions and potential value. This design space can support future research projects and be helpful in designing shared virtual reality applications.

Related Work

Virtual Togetherness, Social Presence

In contrast to the sense of being part of the virtual environment (spatial presence), the sense of being together in a virtual world (social presence, virtual togetherness) assumes the presence of other persons. Virtual togetherness is influenced by the sense of being in the virtual world and the communication between the users in the virtual world [4].

Social Viewing of Movies /Watching Movies Together

Several researchers have investigated social aspects in shared video watching scenarios. Geerts et al. [5] investigated the influence of voice and text chat modalities. They found out that participants feel closer together when using voice chat. Watching 360° videos together was investigated by Tang et al. [11]. In their experiments, participants used tablets for watching movies co-located. It was discovered that participants observed others' physical movements to infer the viewing direction. This strategy is not applicable when wearing HMDs. Designing social viewing experiences for Cinematic VR creates several challenges [10]: e.g. social awareness, viewport sharing, and communication.

Collaboration in Virtual Environments

Projects like DIVE (Distributed Interactive Virtual Environment) [1] laid the foundation for today's research on collaboration in VR. Cordeil et al. [2] compared collaborative data analysis via CAVE and HMD. The participants worked faster via HMD, but no major differences in oral communication and shared focus (time viewing an area) were found. Leap Motion sensors were used for showing points of interest, so the collaborators could see their partners' finger. Additionally, the field of view (FoV) of each user was displayed. Nguyen et al. [9] introduced CollaVR, a tool for filmmakers that allows a shared inspection of 360° via HMDs. Voices and visualization of each other's viewport are used for interaction. Another example of collaboration is VR video conferencing, which was investigated by Gunkel et al.[7]. Dorta et al. [3] compared the social experience of watching a movie together using a walk-in system and VR headsets. In their studies, it was concluded that headsets induce a higher sense of presence, but make the communication between the viewers more complicated. One reason for this was the difficulty to know where the other person is looking at. Even if walk-in systems seem more suitable for social VR experiences, they are rarely available and only applicable to public spaces. Gugenheimer et. al [6] implemented ShareVR, which enables users of the real world to interact with users in a virtual world. They studied asymmetry in visualization and interaction. The derived guidelines will be taken into account in our work.

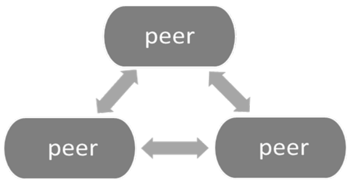

Figure 1: All participants are wearing an HMD and have the same rights for communication.

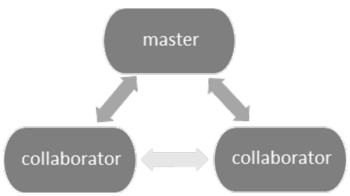

Figure 2: All participants are wearing an HMD. The master can communicate with each member. Each collaborator can communicate with the master.

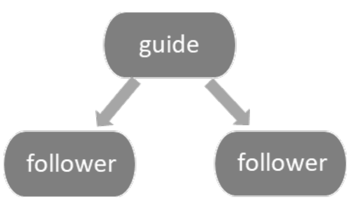

Figure 3: All participants are wearing an HMD. The guide can send information to followers. The followers can only receive information.

Role Concept

Communicating in a group of many users in VR environments can be problematic, as it will result in overloading and negatively impacting the VR experience.

Two main scenarios are conceivable: (1) all users utilize VR devices (e.g. HMD) and are immersed in the VR environment; (2) non-VR users are involved.

The simplest approach for (1) is based on assigning the same roles and permission to all viewers – they are peers (Figure 1). This scenario is suitable for a few users of VR experiences. However, it can originate conflicts in case of many participants and highly active communications.

If more users are involved in the social VR experience, each user has to be assigned a role and permissions. Since a peer-to-peer communication in a larger group can cause overtaxing, we distinguish between the head and the members of a group (e.g. teacher and students).

For the head, who has an outstanding role, we introduce three different roles:

Master: can interact (send/receive) with all members (Figure 2).

Guide: can send information to all members, receives no signals from the others (Figure 3).

Agent: can receive information from all members, sends no signals to the others.

For the ordinary group members, we introduce:

Collaborator: can interact (sending/receiving) with the master (Figure 2) and limited act with other members.

Follower: can receive information from the guide (Figure 3).

Supplier: can send information to the agent.

The roles above expect that all group members take part in the experience using VR devices (HMDs). Communication takes place in the virtual world and has to be technically implemented. The communication channels can be opened or closed by distributing rights.

In the second scenario (2) it is possible, that people watch or even participate in the experience via the desktop/monitor. In such cases, the available technical communication ways are supplemented by real-world communication since no HMD blocks the non-VR group members from each other. In this case, some communication channels are not technically controlled but are influenced by the surrounding. We define the following roles:

Bystander: can see the FoV of the master (who is wearing an HMD) on a monitor, and communicates with other bystanders (Figure 4 and 5). An active bystander additionally communicates with the master (Figure 4).

Observer: can see the FoV of the master (who is wearing an HMD) on a monitor, and does not communicate (Figure 6).

Examples of such scenarios are:

- VR video conferences or workgroups [7] (Figure 1)
- players of a VR game with one master using HMDs and group members in the real world [6] (Figure 4)
- social cinematic VR experiences [10]
- bystanders at a VR fair stand [8] (Figure 5 and 6)

This first approach of a role concept is limited to only one communication channel. For a more detailed structure, it can be split, e.g. in visual and audio channels, and elaborated more detailed. Other roles are conceivable, e.g. followers communicating to each other or non-HMD users who can change the FoV via mouse.

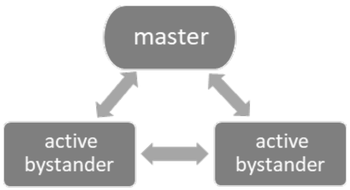

Figure 4: The master is wearing an HMD. The bystanders can see the FoV on the monitor. All participants communicate with each other.

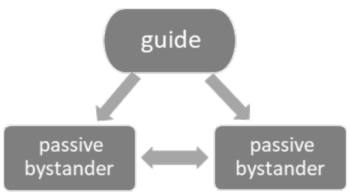

Figure 5: The guide is wearing an HMD. The bystanders can see the FoV on the monitor and communicate to each other. The guide receives no information of them.

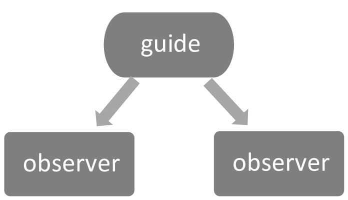

Figure 6: The guide is wearing an HMD. The observers can see the FoV on the monitor, but do not communicate with each other.

Design Space

Defining the roles is an important step for social VR experiences. However, also other components are important and should be taken into account. It needs to consider, if the **participants** are co-located or remote, the number of participants and the relation to each other. All these dimensions influence the design of the application. Additionally, information is needed about the used **interactions**: which communication channels will be used (auditory, visual, haptic), and how they will be triggered. Regarding the **devices**, social VR experiences can be symmetric or asymmetric, depending on the used displays [6]. As input for the communication controllers, speech, gestures or haptic signals are possible. Figure 7 illustrates the design space. For each dimension subdimensions and potential values are indicated. Italic fonts indicate that only examples of possible values are shown. From our perspective, the mentioned dimensions are the most important for social VR experiences in general. However, for special use cases, some dimensions can be less or more important. Even other dimensions can be relevant [6]. Further examples where the design space can be applied are VR experiences in public spaces with bystanders. There a monitor can be used to show the FoV of the HMD-user. In this way, the bystanders can take part in the experience. Such a co-located, asymmetric environment can be added by conversations between the bystanders or even interactions between bystander and HMD-user (master).

Using this design space and regarding the dimension of a social VR experience supports to design such applications and to investigate the influence of the dimensions on social awareness and user experience.

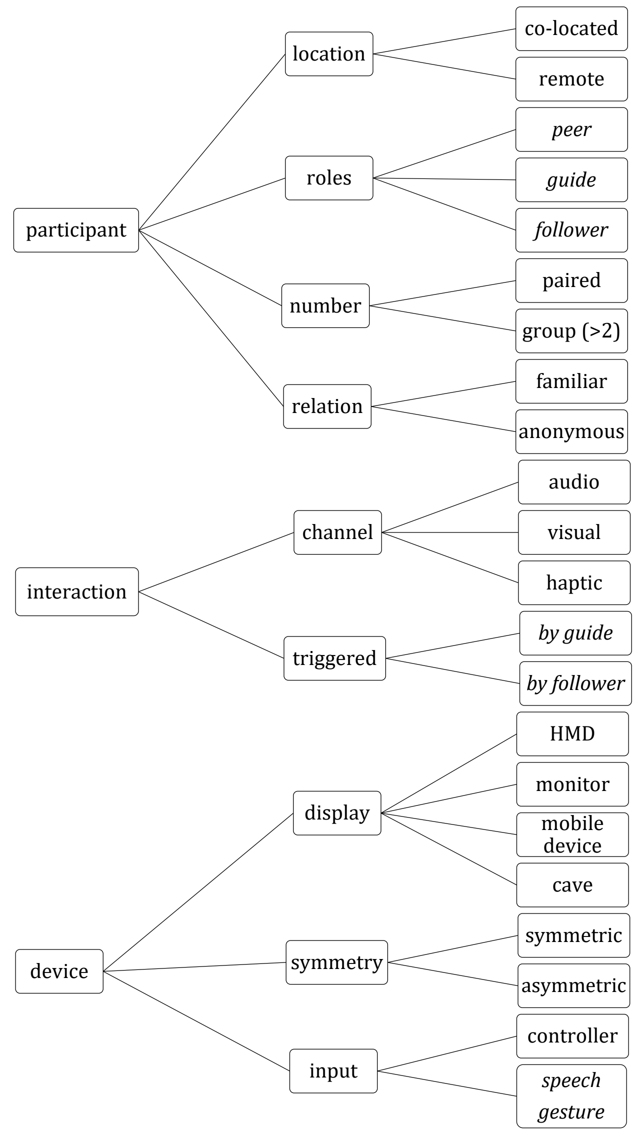

Figure 7: Design Space for social VR applications

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