Experiencing Virtual Reality Together: Social VR Use Case Study

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Figure 1: Two participants trying a Social VR Experience. In a virtual environment, they appear to sit next to each other on an office couch, and can interact with each other.

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Abstract

As Virtual Reality (VR) applications gain more momentum recently, the social and communication aspects of VR experiences become more relevant. In this paper, we present some initial results of understanding the type of applications and factors that users would find relevant for Social VR. We conducted a study involving 91 participants, and identified 4 key use cases for Social VR: **video conferencing**, **education**, gaming and watching movies. Further, we identified 2 important factors for such experiences: **interacting within the experience**, and **enjoying the experience**. Our results serve as an initial step before performing more detailed studies on the functional requirements for specific Social VR applications. We also discuss the necessary research to fill in current technological gaps in order to move Social VR experiences forward.

CCS Concepts

•**Information systems** → **Web conferencing;** *Multimedia information systems;* •**Human-centered computing** → **Virtual reality;**

Author Keywords

Virtual Reality; VR; Social VR; Use Case; Requirements; WebRTC; WebVR; Immersive Virtual Environments

Figure 2: Example view inside VR, showing the other user and a movie projection space

Introduction

With the increased interest for Virtual Reality in the market (both in terms of hardware and software), interest in Social VR has also emerged. This is showcased through VRChat, which attracted "10000 concurrent users" in January 2018[1]. The demand for more Social VR is not surprising as humans are highly social beings. However, current VR systems that allow communication in VR (Facebook Spaces, VRChat and AltspaceVR, to name a few) have severe limitations when it comes to communication interactions [9]. One limitation is that users are represented as artificial (sometimes comic-like) avatars. Even though this might be beneficial for some use cases, this might not be beneficial for many communication settings such as business meetings, or sharing experiences with family or friends. Based on current scientific literature and industrial approach, it is still unclear which use cases are relevant to the different methods users can be represented. Thus, more research is necessary to better understand Social VR requirements.

As a first step to close above gap, we conducted a Social VR study where participants tried a photo-realistic Social VR experience [4, 5] in sessions of 3-10 min followed by a questionnaire and informal discussion. In the VR environment, users sit beside each other on a couch in a 360-degree 2D VR environment and consume a 2D video (see Figure 2), while being able to hear and see each other as photo-realistic video streams. The experience was created to give people a better idea of Social VR. The main contribution of this paper is the study of use cases in Social VR. In this study, we identified 4 key use cases for Social VR: **Conferencing**, **Education**, Gaming and Watching Movies. Further, we identified important factors for such experiences: **interacting within the experience**, **enjoying the experience**, sharing the experience, and being able to move. Our results can guide future studies on more detailed functional requirements, which is essential to design Social VR interfaces and experiences.

[1] https://twitter.com/vrchatnet/status/949453320200052737

Related Work

In the past years, virtual reality saw renewed interest within research communities and industry with the rise of high-quality but affordable HMDs. This has led to new initiatives in shared and social VR experiences as well [10]. Communication has been studied in different virtual environments in the past, for example via large screens, and calibrated camera rigs [6]. This is, by systems that represent users as graphical avatars to create large shared virtual environments, of which [1, 7, 11] give some overview. The realism of avatars in such virtual spaces has also been studied [3].

However, it is not widely understood how such virtual experiences map to the current VR hardware and to collaborative use cases like remote media sharing [2]. One recent work that compares face-2-face communication with embodied virtual reality [12], shows that both "embodied VR provides a high level of social presence" similar to face-to-face interaction, and VR experiences appear to be lonely if other users are not shown. In our preliminary work [4, 5], our main focus has been on using 2D video streaming and web technologies as a basis to bring people together in virtual environments. We have shown that photo-realistic shared and Social VR experiences can be created by using current off-the-shelf equipment and by using a WebVR-based framework. What is currently not studied in literature is which use cases will most likely benefit from Social VR experiences, which we like to address with this paper. Further studies are needed to compare different user representations (like animated avatars versus more photo-realistic 2D and 3D approaches), which is out of scope of this paper.

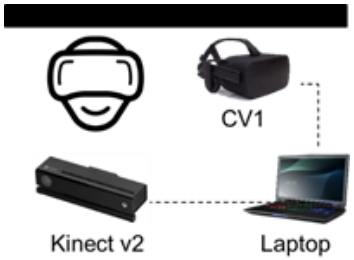

Figure 3: Scheme of our technology setup for each user of the Social VR experience.

Table 2: Details of participants

Total participants: 91
Experienced VR before: 80
Gender distribution: 20 F, 69 M, 2 N/A
Age range: 20 between 18 and 30, 49 between 30 and 45, 21 between 45 and 60

Table 1: Questionnaire Items for Requirements Gathering and their Response Format

Question	Response format
Are you interested in Social VR experiences?	For each option, 7-point scale with labels: not interested at all - low interest - slightly interested - neutral - moderately interested - very interested - extremely interested
Would you like to experience the following topics in Social VR? Sports - Movies - Theatre - Video games - Education - Music experiences - Live TV Shows - Video conferencing - Dating - Adult Entertainment	
Is there anything else you would like to experience within a VR environment?	Free response format
In a VR experience, how important would it be for you to...	For each option, 7-point scale with labels: not important at all - low important - slightly important - neutral - moderately important - very important - extremely important
...share the experience with someone?	
...interact within the experience?	
...enjoy the overall the experience?	
...being able to move within the experience?	

Requirements Gathering

To understand user expectations for Social VR, we performed a requirements gathering and analysis. We conducted our requirements gathering at the European VR exhibition, VR Days 2017 in Amsterdam. In this way, we ensured that our participants at this stage are people who at least have an interest in VR, and/or have experience using VR applications. Table 2 shows details of our participants.

Method

We conducted our requirements gathering using a survey/questionnaire method.Table 1, gives an overview of the questions we asked, along with their response format or scaling method.

Before filling out our questionnaire, participants were asked to try out our Social VR demo, so that they have an understanding of our Social VR application concept. The demo was done in pairs. Each time, two participants were asked to sit with their backs against each other (to simulate being away from each other/remote). The experimenters would help each participant put on head mounted displays (HMDs), headsets and microphones, and make sure that each of these worked properly for the participant. Once this was done, participants could then start their experience in the virtual environment. When a participant did not have a partner to do the demo with, one of the experimenters would perform the demo together with him/her. In the virtual environment, the two participants would appear to be sitting side by side on an office couch. They could see each other and communicate verbally with each other. Moreover, they could see a screen in front of the couch, and could either watch a video clip together or play a game together on the screen. Figures 1, 2 and 3 show the setup of our demo. The screen in Figure 1 shows the view of the participant within the HMD. After trying out the demo and taking off all the equipment, participants were then asked to fill in our questionnaires through a tablet device.

Technology Setup

The demo experience is completely based on web technologies. Our main motivation to utilize web technology is to allow an easy, widespread deployment and low entry burden for end users and developers. For this reason, we currently use off-the-shelf hardware and state-of-the-art

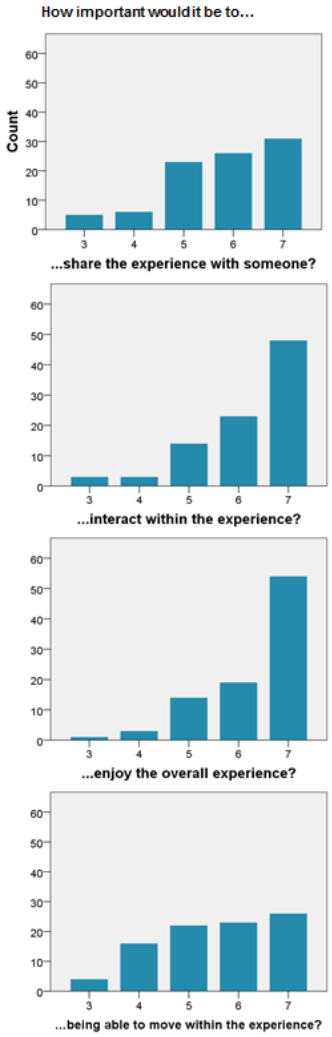

Figure 4: Example view inside VR, showing the other user and a movie projection space

web technologies. In our setup (Figure 3, each user has a specific and similar setup. Each user has a laptop (MSI GT62VR), Oculus Rift HMD (CV1), Kinect camera, headset (Sennheiser HD 201), unidirectional microphone (Power Dynamics PDT3), and gamepad (Xbox 360). It is important to note that the physical environment of the user is aligned with the virtual environment, i.e. if the user looks into the camera, he will look at the other person in the virtual environment. In the virtual environment, the users sit on either the left or right side of a sofa. Thus, the view in the virtual room is different for each of the users. Furthermore, the other user is placed to the right or left of the user according to their view. The placement of users is done by alpha-blending people into the environment based on WebGL shaders. We use this system to record users with a Kinect 2 RGB-plus-depth camera, replace the background with an alpha channel before transmission, and apply alpha-blending after reception to remove the background in the receiving browser (leaving us with a transparent image showing just the user without his/her physical background). Currently, for capture and transmission we use a resolution of 960x540 pixels.

Results

Interest in Social VR Experiences. In our survey 47.25% of the participants expressed that they are extremely interested in Social VR experiences. Only 6 people were neutral or slightly interested, while no people had low to no interest.

Important factors in (social) VR experiences. Figure 4 shows the histogram of responses for the questionnaire items asking users what they would consider to be the most important factors in (social) VR experiences. Based on the charts, "interaction within the experience" and "enjoyment of overall experience" seem to be considered extremely important by more than half of our participants.

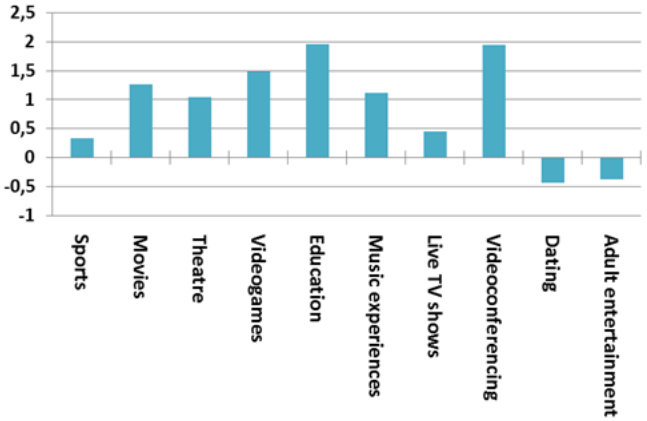

Figure 5: Users interest in Social VR for different application contexts.

Potential application contexts for Social VR experiences. To compare the responses for Q3 (see Table 1), we coded the responses into the score range [-3,3], with neutral (the middle of the scale) as 0 value. We then took the average score across participants and plotted a chart comparing the average scores (Figure 5). Figure 5, shows an overview of the results for the different application contexts proposed in our questionnaire. From the charts, we see that the highest interest is shown for video conferencing and education applications, followed by video games, music experiences and movies.

Discussion & Future Work

Our demo and requirements analysis aims at understanding users' interest in Social VR experiences, specifically on the types of applications that users (who are already familiar with VR experiences) would find most benefiting from our setup, and important factors to consider in a Social VR

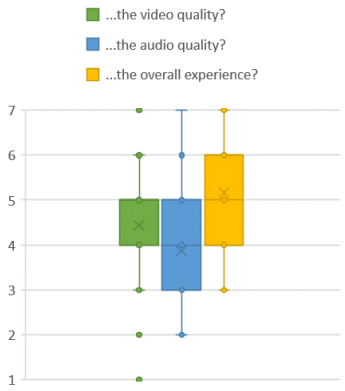

Figure 6: Users response when asked about audio, video, and overall quality of the experience.

Experience. From our results, perhaps not surprisingly, the two most interesting applications to users (i.e. education and video-conference) are those that involve a lot of face-to-face conversations or interactions in non-remote/real world settings. However, the same level of interest was not shown for two other cases with high face-to-face interactions in real world settings: dating and adult entertainment. Our guess is that there are more factors besides realistic representations that need to be considered for dating and adult entertainment in VR.

Users found enjoyment and interaction within the experience as the most important factors among the four factors that we asked them (see Figure 4). However, it is possible that people did not consider the importance of moving in Social VR, based on our example demo. This is, our demo presented an application where users are sitting together on a couch, to watch a video or play a game. The importance of the different factors are suggested through users' responses when asked to rate the system's quality of the experience (QoE, see Figure 6). Users tend to rate the overall experience higher than the audio and visual quality. This hints at users considering more factors other than what they see or hear in the VR setup. At this stage, we cannot yet pinpoint whether these additional factors are due to the enjoyment or interaction in experiencing Social VR. However, our results show that people are interested in Social VR and the need to further investigate the different factors that influence the QoE in Social VR experiences.

One possible down-point of our setup is that the results could suffer from a first-timer effect: people only spent a short time in our setup, and it was the first time they experience Social VR. Additionally, the use case presented in the demo did not yet represent a real application, rather then a Social VR concept. In the future, we plan to do user evaluations in a more controlled setting, and incorporate use cases from the real world where users follow a specific task for a longer period of time, for example half an hour to an hour. We also plan to have a group of users use it on a number of occasions, to see if repeated experiences would change their perception of our Social VR environment.

Our approach of capturing users with a depth-camera and blending them in the VR space appears to be promising to use. The current limitations (low resolution for participants representation of 960x540 pixels in 2D, users do not see eye gaze but others wearing a headset, and no self-view) seem to not hinder our participants from both communicating as well as consuming the immersive experience. One of our future work is to solve the technological limitation such that users will be able to see each other's full face (i.e. removal of HMD image), and that users will be able to see their own body parts (self-representation).

In our setup, we used a photo-realistic representation of the environment and users. Nevertheless, there are other types of representations that can be used in VR, such as mesh-based or point cloud-based avatars [8]. Together with industrial partners, we are planning to perform studies that compare different technologies for Social VR representations. Further, we like to investigate how this technologies map to real application use-cases, particularly related to education, collaboration and live events (e.g. sports).

Conclusion

With the results of this paper, it is clear that we are still at the initial stages of creating Social VR experiences for the general user. The study presented in this paper provides important insight into the types of applications relevant to users within Social VR experiences, such as video conferencing and educational applications. Moreover, the paper

outlines a general idea of the factors that need to be considered when designing Social VR experiences, such as enjoyment and interactivity. More studies will need to be performed to obtain more detailed requirements for specific application contexts. We plan to follow up on this study by performing experiments both related to use-cases and technical choices in Social VR, such as different user representation types in VR, and image processing to remove the HMD within the user representation.

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REFERENCES

1. Steve Benford, Chris Greenhalgh, Tom Rodden, and James Pycock. 2001. Collaborative virtual environments. *Commun. ACM* 44, 7 (2001), 79–85.
2. Azadeh Forghani, Gina Venolia, and Kori Inkpen. 2014. Media2gether: Sharing media during a call. In *Proceedings of the 18th International Conference on Supporting Group Work*. ACM, 142–151.
3. Maia Garau, Mel Slater, Vinoba Vinayagamoorthy, Andrea Brogni, Anthony Steed, and M Angela Sasse. 2003. The impact of avatar realism and eye gaze control on perceived quality of communication in a shared immersive virtual environment. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 529–536.
4. Simon Gunkel, Martin Prins, Hans Stokking, and Omar Niamut. 2017a. WebVR meets WebRTC: Towards 360-degree social VR experiences. In *Virtual Reality (VR), 2017 IEEE*. IEEE, 457–458.
5. Simon NB Gunkel, Martin Prins, Hans Stokking, and Omar Niamut. 2017b. Social VR Platform: Building 360-degree Shared VR Spaces. In *Adjunct Publication of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video*. ACM, 83–84.
6. Peter Kauff and Oliver Schreer. 2002. An immersive 3D video-conferencing system using shared virtual team user environments. In *Proceedings of the 4th international conference on Collaborative virtual environments*. ACM, 105–112.
7. Jason Leigh, Andrew E Johnson, Thomas A DeFanti, Maxine Brown, M Dastagir Ali, Stuart Bailey, Andy Banerjee, P Benerjee, Jim Chen, Kevin Curry, and others. 1999. A review of tele-immersive applications in the CAVE research network. In *Virtual Reality, 1999. Proceedings., IEEE*. IEEE, 180–187.
8. Rufael Mekuria, Kees Blom, and Pablo Cesar. 2017. Design, Implementation, and Evaluation of a Point Cloud Codec for Tele-Immersive Video. *IEEE Transactions on Circuits and Systems for Video Technology* 27, 4 (2017), 828–842.
9. J. Outlaw and B. Duckles. 2017. Why Woman Don't Like Social Virtual Reality. (2017). `https://extendedmind.io/social-vr`
10. Tekla S Perry. 2016. Virtual reality goes social. *IEEE Spectrum* 53, 1 (2016), 56–57.
11. Ralph Schroeder. 2012. *The social life of avatars: Presence and interaction in shared virtual environments*. Springer Science & Business Media.
12. Harrison Jesse Smith and Michael Neff. 2018. Communication Behavior in Embodied Virtual Reality. (2018).