

Effects of Mirrors on User Behavior in Social Virtual Reality Environments

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ABSTRACT

The authors have observed that users gather in front of mirrors on VRSNS such as VRChat. Based on these observations, we hypothesized that mirrors attracted users and conducted an experiment in a controlled environment. The participants were requested to converse in pairs in a VR space with mirrors and posters, and their behavior was recorded. Results showed that, although a certain number of users gathered in front of the mirror, it did not significantly increase their chance of staying. Conversely, we received comments such as "I feel relaxed when I go in front of the mirror".

Index Terms: 500 [Human-centered computing]: Empirical studies in collaborative and social computing—;

1 INTRODUCTION

VRSNS (virtual reality social network service) is an online environment with a social network function that enables users to communicate with others by controlling their avatar in virtual reality (VR) space. Some VRSNSs allow users to design their VR space, such as VRChat (USA, VRChat Inc.) and cluster (Japan, cluster, Inc.), for which software development kits (SDKs) for development are publicly available.

So far, the authors have frequently observed that users gather in front of a mirror and talk to it in the VRSNS spaces. In the real world, mirrors are used to check physical appearances, whereas, in VRSNS, they are used to confirm avatars and observe people during conversations. The fact that the mirrors can be large enough to cover the walls suggests that they are used in a different way than a portrait mirror.

Several studies have investigated the changes in user behavior caused by mirrors. For example, HyperMirror by 'O. Morikawa and T. Maesako [3] shortens the psychological distance between users and facilitates communication by projecting mirrored images of remote users alongside each other. Studies show that the VR mirrors enhance the sense of agency [2] and facilitate teleconferences using monitors as mirrors [1]. Furthermore, studies have investigated user behavior on VR platforms [4]. In this study, we show the effect of VR mirrors on users' behavior.

This paper aims to investigate the effect of mirrors on communication in VR environments. In this paper, as a preliminary investigation, we test the hypothesis that "people gather in front of VR mirrors".

2 EXPERIMENT

We created an experimental VR space (10m x 10m x 4m) with Unity SDK in VRChat (Fig. 1). We placed a mirror (3m x 2m) and an event calendar in the VR space. The event calendar was frequently placed in VRChat, and was placed as a control condition to find the effect of the mirror. We also placed desks and chairs without any collision detection in order to relax the subjects.

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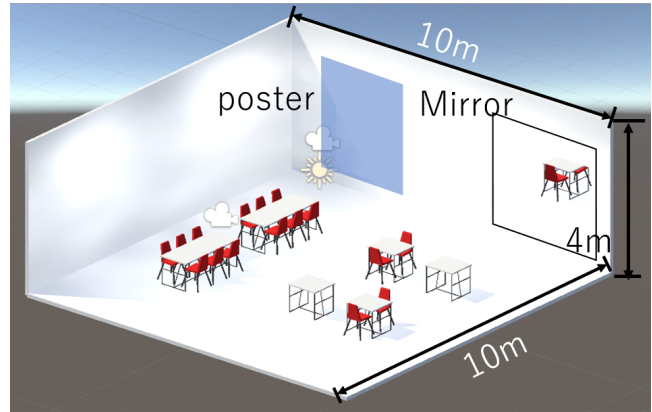


Figure 1: Experiment room

We recruited the participants who were able to use and communicate by VRChat. Eighteen participants (nine pairs) participated in the experiment. Eleven participants used the VR mode with head mounted display (HMD) and seven used the desktop-mode. Among the participants, three pairs (six participants) were in desktop-mode, four (eight participants) were in VR mode, and one (two participants) was in desktop and VR mode. All participants gave informed consent.

After the initial guidelines, the participants were requested to converse freely for five minutes in the prepared experimental space. A fixed-point camera recorded their communication and position in this space. Subsequently, we recorded the participants' experiences.

3 RESULT AND DISCUSSION

We calculated the percentage of participants in nine-area to analyze the time of each participant in front of the mirror and poster (Figure 2). The value of each region in Fig.2 shows the percentage average of all participants, and the color shade corresponds to the percentage scale. The mirror is placed on the upper right and the poster on the upper left sides of the figure. The results show that the average staying-time in front of the mirror and poster is higher than that in other areas. Next, we conducted Willcoxon's signed-rank sum test to verify whether there was a significant difference between the chance level(0.11) and the probability of staying in these areas. We observed a significant difference ($p < 0.05$) on the left middle row and left bottom row columns., where the probability of staying was low. In contrast, we observed no significant difference in the poster and mirror areas. However, these results cannot support our hypothesis of user behavior.

The participant movement data picked from each pair are shown in Fig. 3. The results indicate that the users in desktop-mode move finally, and those in the VR mode move linearly. We observed that users rarely move once they reach their destination.

The analysis of individual movement showed that the behavior during communication was characterized by the mode (VR or desktop). The desktop-mode users moved their bodies in small increments to substitute for body language. In contrast, the VR mode

Poster		Mirror	
28.03	4.98	27.98	
0.43*	7.12	6.32	
0.27*	15.46	9.41	

* p<0.05

Figure 2: The participant staying-time percentage (%) The mirror is placed on the upper right and the poster on the upper left. The color density in the figure corresponds to percentage scale.

users communicated with facial tilt and gestures. Therefore, we assumed that the VR user's gestures are equivalent to the desktop mode user's full-body movements. We observed that users were in close proximity. It seemed that participants were trying to hear each other because that voice attenuation due to distance was implemented in the experimental space.

In the post-experiment questionnaire, users who actively approached the mirror for communication stated that: "I was not particularly conscious of it", "I approached the mirror because the other person was in front of it", "It was easy to have a conversation because I could see myself and other person at the same time by looking through the mirror", and "I feel relaxed when I go in front of the mirror". The group that did not actively face the mirror answered: "I did not notice the mirror," and "I did not go in front of the mirror because the drawing load would be too heavy". The participants who did not notice the mirror said that the objects and devices in the experimental space did not interest them.

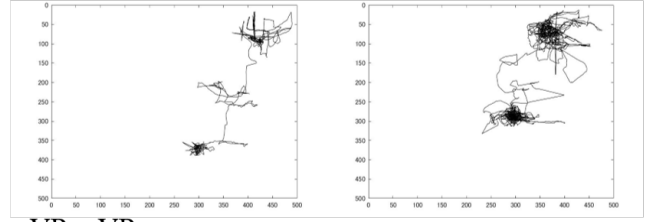
4 CONCLUSION

In this study, as a preliminary study to investigate how mirrors affect communication in a VR environment, we observed users' behavior in a space with mirrors. We used VRChat to conduct our experiment. Eighteen participants (nine pairs) who usually communicate using VRSNS participated in the experiment. Results showed that the presence of a mirror as a method of immersion in the VR space provided a sense of security to the users and that some users used it for communication. In addition, we observed that the user's behavior was influenced by the mode of communication: an HMD or a flat display. However, we could not verify the effect of a mirror on the qualitative change in communication in this experiment. In the future, we would like to investigate further the effect of mirrors on user communication in the VR space.

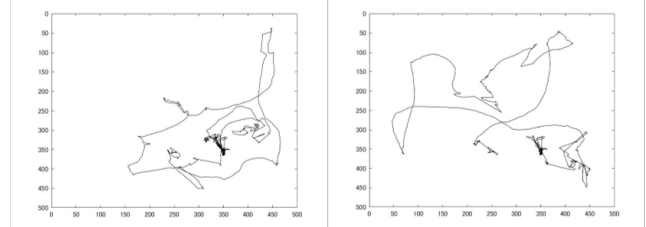
ACKNOWLEDGMENTS

This work was supported by JSPS KAKENHI Grant Number JP19J02096, JP20J23128.

Desktop x Desktop



VR x VR



Desktop x VR

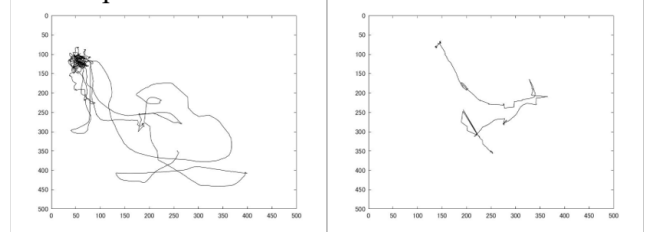


Figure 3: Trajectory data of each pair based on the participation method

REFERENCES

- [1] J. E. Grønbaek, B. Saatçi, C. F. Griggio, and C. N. Klokmoose. *MirrorBlender: Supporting Hybrid Meetings with a Malleable Video-Conferencing System*. Association for Computing Machinery, New York, NY, USA, 2021.
- [2] C. Krogmeier and C. Mousas. Evidence for a relationship between self-avatar fixations and perceived avatar similarity within low-cost virtual reality embodiment. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pp. 127–134, 2021. doi: 10.1109/VRW52623.2021.00031
- [3] O. Morikawa and T. Maesako. Hypermirror: Toward pleasant-to-use video mediated communication system. In *Proceedings of the 1998 ACM Conference on Computer Supported Cooperative Work, CSCW '98*, p. 149–158. Association for Computing Machinery, New York, NY, USA, 1998. doi: 10.1145/289444.289489
- [4] J. Williamson, J. Li, V. Vinayagamoorthy, D. A. Shamma, and P. Cesar. *Proxemics and Social Interactions in an Instrumented Virtual Reality Workshop*. Association for Computing Machinery, New York, NY, USA, 2021.