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The Effect of Camera Height on The User Experience of Mid-air 360° Videos

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ABSTRACT

Mid-air 360° videos are videos shot by placing the camera on the drone or helicopter. However, how the camera height of mid-air 360° videos affects user experience is unclear. The study explores whether the camera's height affects users' immersion, presence, and realism. Results suggest that when the camera height is higher, immersion decreases for acrophobic people while first drops and then rises for others because of the broad vision and beautiful scenery. Higher camera height brings a higher presence and worse realism, especially in distance details. Our work contributes to better understanding and designing of mid-air 360° video experiences.

Keywords: Mid-air 360° video, camera height, user experience.

Index Terms: [Virtual Reality]: Immersive Experience

1 INTRODUCTION

Mid-air 360° videos are videos shot by placing the camera on the drone or helicopter and sending them into the air. Unlike ordinary 360° videos taken by hand-held or tripods, mid-air 360° videos can provide different perspectives and content from daily life, such as the top of a building or a full view of the terrain. Based on this characteristic, mid-air 360° video is often a powerful VR shooting equipment function and an attractive video resource website classification. This study recruited 18 volunteers by watching five mid-air 360° videos shot at different heights to explore whether the camera's height will affect users' experiences.

2 RELATED WORK

Mid-air 360° videos are videos shot from high altitudes up to dozens or even hundreds of meters. Users can view contents by choosing different perspectives or moving their heads when wearing HMD. Some photography teams such as Rocket Lab and AirPano show vast panoramic scenery by shooting mid-air 360° videos. Immersion, realism, and presence are three critical dimensions when evaluating the user experience of the virtual reality environment (VRE). Immersion is perceiving oneself to be enveloped by, included in an environment that provides a continuous stream of stimuli [1]. The more users preserve the system's fidelity related to their equivalent real-world sensory modalities, the more that it is 'immersive' [2]. Presence is how you feel you're 'in' a coherent place produced by the unification of simulated sensory data and perceptual processing produces and it is about form rather than content [2] [3]. The realism in VRE refers to how the virtual environment accurately represents objects, events, and characters in the real world [4].

Camera height affects user experience. The camera's height with the best user experience is far lower than the actual eye level. Placing the camera at about 150cm would make the most comfortable experience whether the audience is sitting or standing [5]. When the camera position is lower than body height, this difference between the camera and eye heights are more accepted. Besides, sitting postures are preferred and can be adapted easier than standing [6]. However, current research about the impact of camera height on user experience is mostly concentrated on ±1m of the human body and near-grounded 360° videos. The research on user experience for camera heights that are tens or even hundreds of meters higher than ground is missing.

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3 EXPERIMENT

Firstly, 18 participants (eight males, ten females) filled out an online background information questionnaire including gender, VR experience, etc. Participants are all students in the university. Two fear heights, while the others are not. Then we explained the use of HMD equipment and helped them adjust to a comfortable state when watching an animated panoramic video to reduce the novelty effect. Because user posture affects experience, all participants were instructed to sit closer to daily behavior while watching videos. Participants watched five 360° videos randomly; the camera heights are about 1-2m(H1), 2-3m (H2), 10-20m(H3), 80-100m(H4), and 100-150m(H5) respectively. The main title of H1 to H5 is 'day at Disney,' 'street view in New Year,' 'Lucerne,' 'monastery' and 'Istra river.' All videos' resolution is 4K, and watching length is 1.5min. Contents posing threats to perception, such as cliffs and waterfalls, are avoided.

Figure 1: Screenshots of H1, H2, H3, H4, H5 (from left to right)

Users completed a user experience questionnaire (UEQ) after watching a video and a user interview after viewing all five videos. The UEQ is designed from three dimensions: immersion, presence, and realism in a 7-point Likert-type response format (1 = totally disagree to 7 = totally agree). We used S8 to access general immersion as shown is Table 1. The wide field of vision enhances users' indulgence in virtual environments [7]. Field of view is an indicator of quantifying immersion [2]. We used S9 to measure it. Before the formal experiment, we did a small-scale test inside the laboratory (N=4), and three participants said that beautiful scenery in some videos could promote immersion, so we added S7.

Based on the presence questionnaire (IPQ) [8], we tested general presence by S4. Attractors like fear can affect presence in VRE [4]. Virtual high heights exposure would increase physiological stress, fear, and both physical and cognitive loading [9]. We used S2 to measure it. The presence of VRE depends on the speed of people's attention shifts from the physical environment to VRE [4]. Based on the Presence Questionnaire (PQ) [1], we use S1 and S10 to measure presence. We use S3 to understand the user's overall sense

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of realism, S5 for the perception of close details, and S6 for distant details.

Table 1: Statements of User Experience Questionnaire

Statements of User Experience Questionnaire
S1. I was able to adapt quickly when I started watching the video.
S2. I did not feel fear of heights during watching.
S3. I felt real when watching the video.
S4. I had a sense of "being there".
S5. I could see close details clearly.
S6. I could see distant details clearly.
S7. The scenery was beautiful when watching the video.
S8. I forgot the real world while watching the video.
S9. The video provided me a wild view.
S10. I could quickly adapt to the real world after watching the video.

4 Results

Reliability and Validity of UEQ. The KMO value of UEQ is .86. Therefore, UEQ is appropriate for exploratory factor analysis (EFA). The results of EFA indicate that extracting three factors and the questions set are reasonable. The values of Cronbach's α of each dimension are all greater than .7, and the overall value is .87. Therefore, the reliability and validity of UEQ are acceptable.

Participants Information. Participants all have heard of VR technology, and 77.8% have experienced VR. Among participants who have experienced VR, only 14.3% have seen VR videos, while most have experienced VR games. 83.3% have not heard of mid-air 360° videos, and two have watched them without good experience. The relationship between the participants' background information and the experience shows prior experience only slightly affects immersion (r .53, $p<0.05$) and has no significant relationship with presence and realism.

Immersion. The immersion of acrophobia people is significantly different from others (eta-squared .48, $p<0.05$). However, the presence and realism between these two groups are not significantly different. With higher camera height, the participants' immersion with acrophobia decreases (r -.25, $p<0.05$). Others' immersion first weakens and then increases. Most participants (15) said that when the camera height was slightly higher than usual, the objects in videos were still familiar. This inconsistency led to low immersion. When the camera height is much higher, immersion increases in line with the perception of wide views (r .45, $p<0.05$) and beautiful scenery (r .44, $p<0.05$). Most participants (17) expressed that they preferred mid-air 360° videos rather than near-ground videos because they would be calmer and more relaxed after watching mid-air 360° videos. However, one stated mid-air 360° videos are lack interaction.

Presence. When the camera height increases, the user's sense of fear (r .37, $p<0.05$) and presence (r .51, $p<0.05$) increase. However, fear is not only related to camera height but also related to other factors. Through interviews, it is found that in 360° video, the participant's perception of height is affected by shooting speed. The moving speed of H5 is slower than H4. Some participants reported that they felt like looking at panoramic photos when watched H5. When the camera height increases, the adaptation from real world to VRE at the beginning of watching is lower (r -.32, $p<0.05$) while has no significant effect on the user transforming from the VRE to the real environment. According to the interview, participants thought lower camera height was close to the daily viewing angle so that they could adapt to VRE quickly. But high camera heights providing different perspectives led to more time to adapt.

Realism. The higher the camera height, the lower the overall realism (r .26, $p<0.05$) and the perception of distant details (r .49, $p<0.05$). Close details don't have significant relationship with the camera height. In the perception of close details, H5 and H2 are the lowest. In user interviews, many (eight) users said that the lights of H2 irritate the eyes. Twelve users said there were no surrounding buildings in H5, the boundary of nearby and the far are not obvious, so the perception of close details is weak. For the other three videos, participants (14) said that camera height did not have much effect on the perception of close details, and they were all clear.

Viewing Posture. Even being notified to sit during the entire procedure, five participants stood up while watching videos. To not affect their experience, the researchers did not interrupt them but reiterated the rule of sitting when they filled out a questionnaire. Their interview reflected that their fear increased when standing rather than sitting, especially when watching mid-air 360° videos. In this regard, we recruited four volunteers to investigate it. Participants said when standing, the speed of video movements would be accelerated in perception. No other support points except feet made a weak sense of security and more fear leading to greater immersion.

5 Limitation And Future Work

The videos used in this experiment are from an application. So, the contents and heights of videos cannot be precisely controlled. We will consider shooting similar panoramic scenes at different heights by ourselves in future experiments. Secondly, users' feedback reflects that they feel more immersed when standing than sitting, especially when watching mid-air 360° videos. The viewing posture may affect the user experience of mid-air 360° videos. This study did not further expand it, and it is worthy to be studied in subsequent researches.

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