The Impact of Camera Height in Cinematic Virtual Reality

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ABSTRACT

Watching a 360° movie with Head Mounted Displays (HMDs) the viewer feels to be inside the movie and can experience it in an immersive way. The head of the viewer is exactly in the same place as the camera was when the scene was recorded. Viewing a movie by HMDs from the perspective of the camera can raise some challenges, e.g. heights of well-known objects can irritate the viewer in the case the camera height does not correspond to the physical eye height. The aim of this work is to study how the position of the camera influences presence, sickness and the user experience of the viewer. For that we considered several watching postures as well as various camera heights. The results of our experiments suggest that differences between camera and eye heights are more accepted, if the camera position is lower than the viewer's own eye height. Additionally, sitting postures are preferred and can be adapted easier than standing postures. These results can be applied to improve guidelines for 360° filmmakers.

CCS CONCEPTS

• **Human-centered computing** → Virtual reality

KEYWORDS

Cinematic Virtual Reality; 360° movie; camera height, eye height

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1 INTRODUCTION

The **height of the camera** plays an important role for composition of scenes in traditional movies. A high angle camera looks down at an object or character and the viewer feels more powerful. A low angle camera looks up and makes the object/subject more important. This is also, even more, essential for Cinematic Virtual Reality (CVR), where the viewer watches 360° movies using a Head Mounted Display (HMD) or other VR devices. Because of the perspective in CVR-videos the feeling of being shorter or taller depending on the camera position is stronger than in traditional movies. However, there are many situations in a story, where the viewer should not be influenced in such a way.

Furthermore, the **eye height** of a person is decisive for human perception. It is used for scaling sizes, velocities and distances [2]. Distances and heights of viewed objects are determined by using the viewer's own eye height. So, a wrong camera position can lead to disorientation in the movie world. In addition to this visual source of sensory information, the postural information is important. Since the viewers have knowledge about their own posture (e.g. sitting or standing), this can affect the perception of the CVR experience.

2 DISCREPANCIES IN EYE HEIGHTS

In 360° video guidelines it is recommended to place the camera at head height [3]. Because humans have different body sizes, it is difficult to implement such advice. To investigate whether the height of the camera influences presence, sickness and user experience we established three tasks and carried out a user study with 26 participants (17 males, 9 females).

In the **first task** we wanted to find out if the feeling of the user for their own height in virtual reality (VR) corresponds to the true body size. For this, a virtual environment (VE) was created which included some characteristic furniture of standardized sizes. The users could look around freely and change the height of the virtual camera using a controller button until it corresponds to the feeling having the right height in the virtual world. 80% of the participants identified the VR height lower than their real height.

In our results there is a tendency for people to underestimate their own height. This can be caused by the fact that people are used to seeing the world from a lower perspective and so the world from this perspective is more familiar. We usually sit for long periods of the day. As children we are also used to being shorter and to having a lower eye level. Additionally, all participants started with a virtual eye height, which was lower than the own height, which could have influenced the outcome [1].

The second and third task were conducted for finding out if small differences (10 and 20cm) between the physical and virtual eye height irritate the viewer. We distinguished between a sitting posture (task 2) and a standing posture (task 3). The participants watched very similar short videos which were recorded in several heights: They were not informed about the differences of the

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videos. The videos had no emotional content, since we were interested in the acceptance of the recorded environment in the chosen camera height. This should not be influenced by the story. The videos for task 2 were recorded in a sitting situation at a table, for task 3 in a standing situation in a pedestrian zone. After each video, parts of a questionnaire were answered. The questionnaire included questions about presence, simulator sickness and user experience. At the end of the study, some comparative issues were asked.

The results show that the presence suffers less, if the camera is too low compared to the case where it is too high. Also, the viewing experience is better in the case where the camera is lower. This outcome occurred in sitting postures, as well as in standing postures. Additionally, for both postures (sitting/standing) nearly twice as many participants had strange feelings watching the video with the high camera position.

Most of the participants, who saw videos where the camera was too high, could tell which video was filmed on their actual eye level and preferred the video which represented this height. Comparing both test cases, sitting and standing, it is recognizable that this effect is stronger for the sitting posture, where all participants identified the video with their own height compared to videos recorded too high. Against that, fewer people identified the video with their own height compared to the video recorded too low. That suggests the assumption, that in sitting postures, the viewer often does not recognize if the camera height is some cm too low. The difference seems to be less important in this case.

The results show that people have less problems when the camera is too low than when it is too high. Differences of 10cm were accepted by most of the participants, even if the camera corresponding to their own eye height was preferred.

Consequently, filmmakers should place the camera too low rather than too high.

3 DISCREPANCIES IN POSTURES

Since the filmmaker does not know if the viewer will watch the movie in a sitting or standing posture, it is important to know, how a movie recorded from a sitting posture influences a standing viewer – and vice versa. Using the same videos as in the first study, 20 participants (12 males, 8 females) watched standing a video which was recorded for a sitting height and sitting a video which was recorded for a standing height.

There were no significant differences regarding sickness and presence. However, more people specified a strange feeling of not having the right height, when they stood. Only few people desired to stand up for watching a video recorded on a standing level (15%). More people wished to sit down watching a video recorded on a sitting level (40%). The desire to take the right posture was significantly higher for the standing persons (exact fisher test, p=0.06). Asking which of the videos was more difficult to watch, 55% chose the video which was watched standing and 30% the video which was watched sitting.

The results show that sitting postures were preferred even for the high camera had a standing position. For the participants it was easier to adapt a sitting posture to a virtual standing position than vice versa. This outcome corresponds to the result of Leyrer et al. [2] about the importance of postural information for determining the eye height.

In our study, the viewers had the desire to sit down, even if the camera had a standing position. The fact, that it is more comfortable to sit than to stand, could have influenced the result. Additionally, viewers are used to sit down when watching movies. Also, the content and the length of the videos could have influenced the outcome. We will continue our research with different movie lengths and contents.

So, filmmakers can place the cameras at the eye level of a standing person. This position is comfortable for the most users in standing postures as well as sitting.

4 CONCLUSION

This research was our first step for investigating which camera heights and viewing postures are advisable in Cinematic VR.

Users prefer to sit down when watching videos. In our study, most viewers are able to adapt their sitting posture to a camera height on a standing level. Videos recorded in standing heights are comfortable for most users in sitting postures, as well as standing. Assuming that viewers are sitting while watching movies, filmmakers can place the cameras in sitting as well as standing positions, depending on the story.

Regarding less differences between camera and eye, as sitting and standing, we found that camera positions, lower than viewer's eye level, lead to fewer difficulties than higher camera positions. Accordingly, filmmakers should place the camera too low rather than too high. Considering various body heights, the camera position should be oriented to shorter persons, since it is easier to adapt lower camera heights.

There are several explanations for the finding that a too low eye height seems to be a smaller problem than a too high level. On the one hand humans change their eye height in daily life very often. They are used to watch from lower positions. However, to experience the environment from a position higher than the eye height is seldom. On the other hand, humans have grown up and have already seen the world as a shorter person.

It is generally accepted that the relatively new medium Cinematic VR needs a new language for telling the stories. Neither the language of traditional filmmaking nor of computer-generated VR can be adapted directly. The height of the camera is only one instrument which has to be considered together with all the other instruments. Our research is one step in this direction.

We are convinced that these results are useful for further development of guidelines for 360° filmmaking and also for viewer recommendations.

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