DOI 10.34658/9788366741102.2

The camera as a way of telling stories with images in 360 animations using VR technology

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Abstract. *VR technologies have found their place into the film industry, potentially revolutionizing standards of cinematography. Aim of this work was to investigate and compare the perception of space depending on the type of the camera. For this purpose, a special 360° animated film was created with two types of camera: one following the viewpoint of a character and another one defined by shots. As a result we can tell that the following camera seems to be more attractive to a recipient, which means a greater portion of a material was perceived and with a greater comfort of viewing experience.*
Keywords: *virtual reality, virtual camera, 360 degrees animation, space perception*

1. Introduction

Virtual reality technology is currently experiencing a strong boom and has become a fully fledged medium in the film and games industry. It allows the viewer to experience an extremely realistic representation of digital environments and accompanying phenomena, mainly through the use of special goggles (HMD - Head Mounted Display), which allow the user to see the virtual world presented from different points of view, increasing the feeling of presence in digital space.

The aim of this study is to investigate the perception of space and accompanying narrative elements of the environment using selected observation points (virtual cameras) in 360° animation. An important outcome of the project is also to determine which way of positioning the camera in space was the most attractive to the viewer, meaning adequate perception with no sense of discomfort.

2. Related works

VR is most often used for games, but also finds its way into animated films [1, 2]. The short animated films available to view in 360 degrees are relatively new productions, due to the popularization of VR goggles over the past few years. In 2016, an animation called 'Story: Pearl' became the first VR film to be nominated for an Academy Award. It tells the story of a father-daughter relationship shown in the long view of their lives. Throughout the animation, the camera sits motionless on the passenger seat. The authors suggested changing environments - changing weather, actors, the road - and left the camera at one point.

Another example of a 360 video from the Google Spotlight series is 'HELP'. In this case, the camera follows the action, stopping and accelerating with the pace of development. The camera mainly operates at eye level of the characters. Long spectacular departures and raids were also added. The viewer becomes an observer of the centre of the action moving according to the director's plan.

The film "Invasion" presents in a playful way the story of a bunny witnessing an alien landing. As with "Story:Pearl", the camera is set at a single point - the centre of the interaction between the characters. As the characters talk, the viewer often has to turn their head 180 degrees to jump between the actors. The movement of the main character's eyes is a way of telling the viewer in which direction to look.

Released in 2015, the film about the race made in the famous Star Wars universe was designed to expose the technological possibilities of virtual reality. In this case, the storyline gives way to the dynamism and emotions evoked by the immersion in a moving virtual world. Because the immersion of VR goggles is so great, many projects are focused on stimulating the senses of orientation and space, and only secondarily on a possible narrative.

There are several ways to represent an image in VR technology. Both static and moving cameras with different perspectives can be used. Determining the position of the viewer in the VR environment is still a field for experimentation, which is of considerable importance since the choice of camera, conscious or accidental, determines the whole experience.

Although animations created in 360 degrees technique present the world in a spherical panorama, at a given moment the viewer can see only a fragment of the presented image. This is due to a simple fact - the technological limitation of goggles related to the viewing angle. For example, HTC VIVE and its 145-degree viewing angle represents approximately 40% of the potential view. Despite the fact that there is no guarantee whether users will pay attention to a particular part of the panorama, the conscious implementation of the camera will affect the way it is perceived. Without the director's power over the camera, the movement of the frame is controlled by the user, who reacts to the provided visual stimuli.Referring to a traditional camera, we can distinguish five consecutive visualisation elements that attract attention and thus influence the direction of the user's gaze [3]: movement, the brightest object, the most saturated object, the actor's eyes, the object containing the most visual contrast.

The virtual experience begins with a predefined initial direction chosen by the creator, from which the exploration of the world and the story begins [4]. Then, the function of directing the viewer's attention ceases to be the appropriately planned camera and editing, this major responsibility is taken over by the content of the film itself. As a result, the values of such elements as image, camera, sounds, dialogues and action are are enriched with an additional load of directing the viewer's attention.

Movement plays an extremely important role in virtual reality. Firstly, movement affects the peripheral part of vision, provoking a change in the point of view. Secondly, movement increases visual intensity, and in the experience of immersion is more spatial and complex, so the scale of the effect is greater.

The use of these elements makes it possible to identify and design Points of interest (POI) [5, 6]. Such points allows to assume the behaviour of the viewer's gaze. According to the principle of contrast and similarity, continuum of movement [3] POI allows to control the visual intensity generated by eye movements. Similarity in the continuum guides the viewers' attention when they look at the frame reducing the visual experience and, conversely, contrast increases it [7, 8, 9]. The research conducted will also focus on defining the area observable by the viewer.

3. Methodology

The following assumptions were made in this research:

— The idea and the dedicated script are the author's own creation. Storyboard can be seen on Figure 1.

— The animation was created in Unreal Engine, and will be presented in an immersive environment using the HTC Vive virtual reality goggles.

— A linear animation was adopted, which was not an interactive image - there was no interaction between the viewer and the environment.

— Two variants of virtual cameras will be compared - one following the character, the other static for each scene where each of the observation points (virtual cameras) provides free head movement to the user.

— The research will include a comparison of the results obtained in two variants of the designed cameras. Therefore, the designed scenery will contain key objects set in such a way as not to discriminate a particular view - in each variant

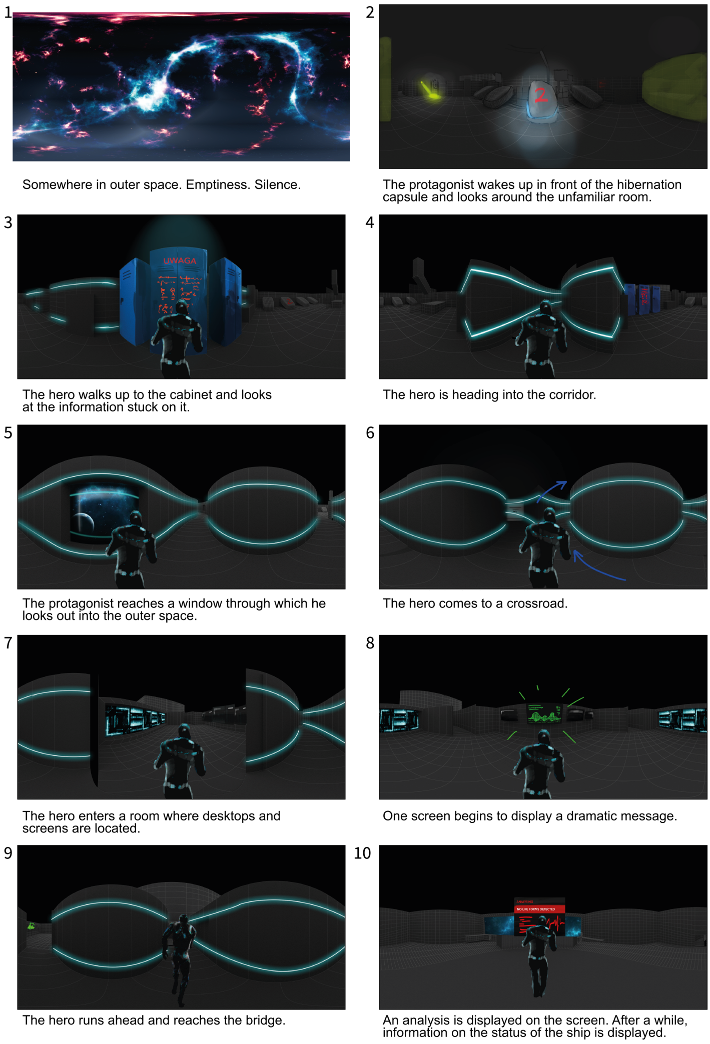

Figure 1. An original storyboard of the film with panoramic frames that had to be viewed in VR. It shows the action for the following camera - from the eyes of the protagonist.

the viewer has the opportunity to see the key objects. The room designed for the test can be seen in Figure 2.

— The verification of the reading of the information contained in the space will be done by means of a questionnaire and in-depth interviews verifying the information remembered while watching the animations.

— For each of the observation points (virtual cameras), the following parameters will be verified: the frequency of view change (camera movement) and the position of the point of interest (camera direction) - as important in relation to the viewer's involvement in exploring the space.

— The research will be supplemented by a subjective evaluation of the reception of the presented animation in relation to the attractiveness of the mode of transmission and comfort of reception of the content.

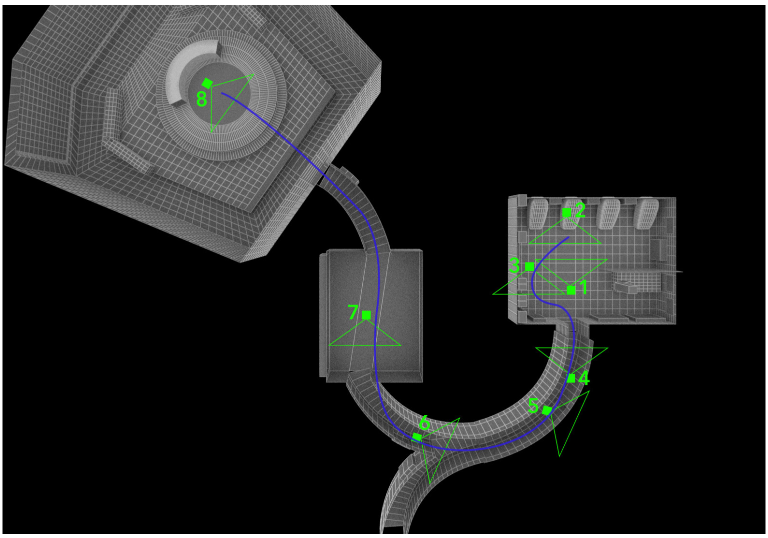

Figure 2. Top view of a map showing the place where the film is set. In green are marked consecutive locations of static cameras. Blue shows the route of the character.

4. Procedure

A study was conducted on 2 camera variants:

— a still camera, defining individual shots.

— a camera following the protagonist.

For each camera variant, 5 recordings of the animation experience were analysed using the HTC Vive. The final outcome of the study will consist of the following components: graphs of head rotation during the animation to determine the extent of changes in camera position, a visual representation of the goggles viewing area in the form of a 360° panoramic image, a questionnaire response table determining the perception of the content presented, a recording of the cameras. Participants were asked to watch the animation. The experiment was carried out in a seated position. The participants belong to a group with no or little experience related to virtual reality. Subsequently, individuals were asked to give responses about the material they watched and their feelings about the comfort of receiving presented material. The aim was to collect information regarding the relevant of the scenario's content presented in the space of the presented world accompanying the course of the animation and to determine the most favourable point of view for the user.

5. Results

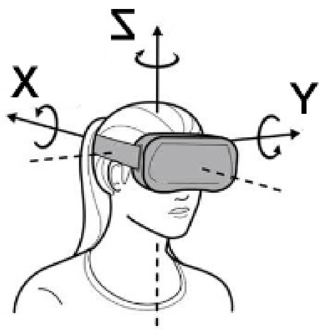

Figure 3. On the left, a photo of the survey being conducted. On the right, a picture illustrating the rotation axes for VR googles.

Figure 3 shows an example of how the study was performed and the marked axes for the VR googles. Figures 4 and 5 represent the camera rotation in three axes for the two analysed camera variants during the VR experiment. Thus, both graphs refer to the same same environment and animation, with a difference in viewpoint. The vertical axis of the graph represents deviation of the camera from the initial value expressed in the angular unit radian. The horizontal axis is the time of the VR experience.

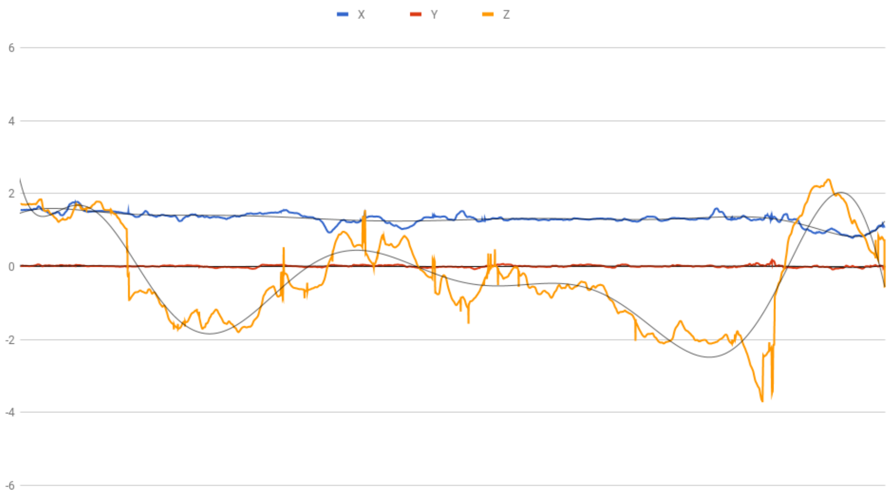

Figure 4. Average deviation values for individual axes for the fixed camera variant. The blue axis describes the X axis. The red axis Y. Yellow Z axis.

Rotation X (blue) represents the rotation of the head described as an up-down relationship. For graphs, a value close to 1.57 (radian) indicates a camera looking ahead, while a value of 3.14 indicates a camera looking as far up as possible. This is due to the starting position of the camera, which is fixed in the downward direction. Both the first and second camera have similar values. The following camera is characterised by less rotation in the X-axis - this means that, on average, participants had their head slightly downwards. The magnitude and dynamics of the relative changes for both variants are comparable. The Y rotation (red) represents the turning of the head to the shoulder. In the case of both camera variants the graph remains stable and uniform with very minimal deviation. Z rotation (yellow) represents the horizontal rotation of the head around itself. Of all the lines, it is the most volatile. The graph of the stationary camera variant of the Z rotation is characterised by greater dynamism and amplitude of change. Moreover, in this case we even observe a rotation of almost 360 degrees in the final phase of the graph.

Regarding the questions that the respondents were asked about the elements in the film, the answers are as follows. To 1 question - what number was on the capsule? - only one person answered. No one recognised the number on the capsule in the still camera group. To the 2nd question about the information on the cabinet

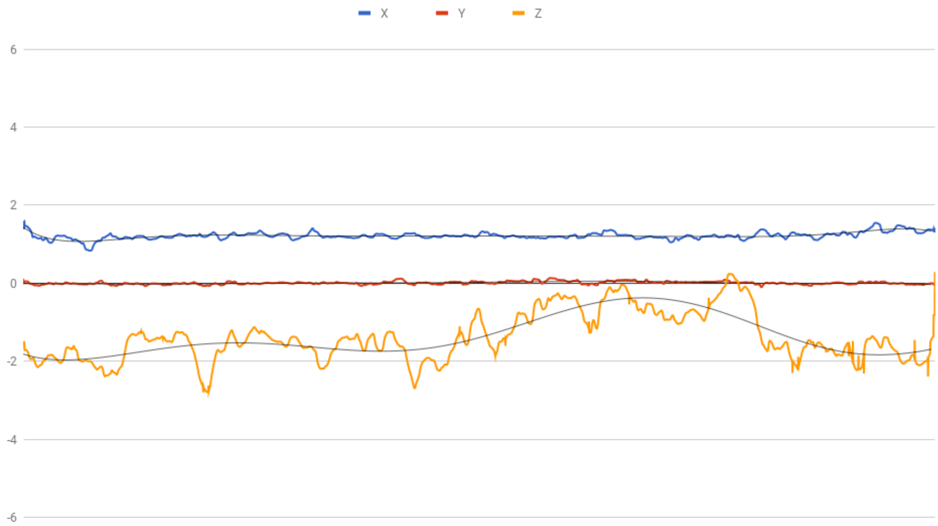

Figure 5. Average deviation values for individual axes for the following camera variant. The blue axis describes the X axis. The red axis Y. Yellow Z axis.

about memory loss and hibernation, no person read the details. However, people noticed the ’stop’ in the animation and vaguely perceived the warning ’caution’ caption, while the rest of the text appeared unreadable. Question 3 - how many planets were visible outside the window? - was answered by 2 respondents. No person in the still camera group knew the correct answer. Question 4 - were living creatures detected on the ship? - was answered correctly by 80% of respondents in both groups. From the above summary it can be seen that the following camera group remembered more of the material presented in the animation. Only in the fourth question the statistics are the same for both groups.

Regarding the respondents’ statements on the comfort of watching the animation, the statements are as follows. For the still camera group, it was unanimously stated that discomfort occurred when the shots changed. For the following camera, discomfort was recorded when the protagonist was running. Also twice as high a percentage belongs to the still camera group, they were those who noted a loss of orientation or a loss of plot.

6. Discussion

The subjects had no previous experience with VR technology or it was sporadic, so that the perception of the material presented was suppressed by the mere experience of virtual reality, and thus the perception of details was limited, which in short can be described as technology shock. Subjects stated that they were engrossed in the virtual space to the extent that they did not focus on following the narrative. Furthermore, individual attitudes and subjective levels of immersion influence perception, which by the very definition of subjectivity is unmeasurable but worth observing. Illustrating with the example of the project, some people set themselves to the experiment on an exploratory task, while another part set themselves to a passive, slow assessment of only the closest surroundings.

Based on the results, it is found that only 10% of all respondents answered the first question correctly, 20% answered the second question correctly, no person knew the answer to the third question and 80% answered the last question about narration correctly. In the first two questions there were twice as many correct answers in the following camera group. Thus, the overall perception of details in the designed animation of the part is rated as low. However, a difference between the groups is noticeable, with a predominance of good answers on the following camera side. At the same time, the same group reported less discomfort which suggests an advantage of the following camera over the still camera in the sense of attractiveness of perception.

The data collected shows that users hardly ever turn their heads in the Y-axis, which is dictated by the natural human predisposition. Such rotation, if it occurs, is usually connected with the movement of the whole body of the respondent. Placing camera directed over the character causes a general tendency to change the angle of looking downwards. This is due to the fact that the person places the dominant, moving object in the centre of the of the visual field. Rotation in the horizontal panorama represents the strongest movement in both groups. The variant of the still camera defined by shots is characterised by higher rotation in the horizontal panorama. This is related to the adaptation effect to the new environment after each shot change. At the moment of changing the shot, there is a moment of awareness of the change of environment, then orientation in space and finally the search for the protagonist, which can be colloquially called each time "looking around". Finally, each change of shot involves a change of the angle from which the key action is seen, so the graph is characterised by abrupt changes as opposed to the following camera with more gradual transitions.

Based on the above data, the following camera is more attractive in reception, which means a higher level of perception of the material, with at the same comfort of the experience.

7. Conclusions

Virtual reality technology is still in its early stages. Viewing through currently available HMD systems still leaves much room for improvement in terms of comfort and image quality. The resolution of HMD screens, lenses and the dragging cable still remain a problem that should be solved in the near future. Ultimately, the quality of reception depends on the experience created. Appropriate planning of the camera, i.e. the choice and timing of changes in position, will improve the appeal of the message and guarantee the right level of immersion.

Acknowledgment

This article has been completed while the second author was the Doctoral Candidate in the Interdisciplinary Doctoral School at the Lodz University of Technology, Poland.

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