



**Linnæus University**

Sweden

Bachelor Thesis

# Guidance in a 360-degree video with the help of special effects

*Attracting attention to a specific object or segment in a 360-degree video using graphical elements, lights, and colours.*



*Author: Anes Tenic  
Supervisor: Romain Hault  
Examiner: Jorge Luis Zapico  
Semester: Spring 2018  
Subject: Media Technology  
Level: Bachelor  
Course code: 2ME30E*



## Abstract

360-degree videos offer an immersive experience which is hard to find in traditional videos. The entire scene is floating around the viewer, and a feeling of being there is common. However, something traditional videos have compared to 360-degree videos is control of the outcome. The filmmakers decide what they want to show and how they want to guide the viewer. The control is still an issue in 360-degree videos. In this thesis will the focus be on how a viewer can be attracted to an important part of a scene. This work is concentrated on methods and techniques in the post-production part of video production. The techniques are mainly video effects.

The user tests involved 16 participants with different backgrounds including an expert in the field. The participants watched three 360-degree videos each with the same content, but with different techniques made in the post-production part to guide them. It was one video with graphical elements to guide them, one with light effects and one with colour effects. Interviews gave a deeper insight into the participant's experience and opinions on the three videos.

The video effects affected the participants positively and negatively. The participants were mostly satisfied with effects consisting of graphical elements but not as much with colour. The users lost a bit of their freedom to explore a scene with the light effects, but they were useful when it came to guiding towards something. The participants did find the guiding lines and spotlight as the most suitable methods to attract attention; the spotlight was the most preferred of the two. The red circle effect and the warm/cold colour effect was the least preferred, the warm/cold colour effect as the least preferable.

The effects helped to attract the viewer to a section of the video, and the user's got a better understanding of the concept. However, more research need to be done to draw attention towards something. A combination of elements like light effects and graphical element effects could improve the post-production part. Research in the future regarding the opportunity to combine techniques from an entire video production needs to be conducted for a significantly more effective way to attract attention to an important side of a scene, without the viewers losing their freedom of exploring, it includes both the post-production side but also methods to attract attention in a set.

## Key words

360-degree video, attract attention, video production, post-production, video effects.

## Thanks

Romain Herauld and everyone who participated in the user studies.



## Table of contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
1.1	<i>Background .....</i>	<i>1</i>
1.1.1	360-degree video .....	2
1.1.2	Visual attention and selective visual attention .....	3
1.1.3	Graphical elements, light, and colour.....	3
1.2	<i>Problem Definition .....</i>	<i>3</i>
1.3	<i>Research Questions .....</i>	<i>4</i>
1.4	<i>Limitations.....</i>	<i>5</i>
1.5	<i>Related Work .....</i>	<i>5</i>
1.5.1	Techniques used in a set to direct attention in a 360-degree video.....	5
1.5.2	Heatmaps functionality in a 360-degree video .....	5
1.5.3	Draw attention with visual methods.....	6
1.5.4	Directing audience attention in 360-degree videos .....	6
1.5.5	Storytelling and its role in a 360-degree video.....	8
1.5.6	Robot navigation with spherical images .....	9
1.5.7	Regions of interest in an omnidirectional image .....	9
1.5.8	Design challenges in 360-degree videos and game world design.....	10
1.5.9	Visual attention guided eye movements for 360-degree images .....	10
1.5.10	Prediction of activity in a 360-degree scene.....	11
1.5.11	Video game concepts used in a virtual environment .....	11
1.5.12	The FOV in a 2D display compared to an omnidirectional space ....	12
1.5.13	Subtitles used in a 360-degree video.....	12
<b>2</b>	<b>Method .....</b>	<b>13</b>
2.1	<i>Description of methods and how to implement them.....</i>	<i>13</i>
2.2	<i>Implementing the 360-degree videos .....</i>	<i>14</i>
2.3	<i>The post-production of the 360-degree videos .....</i>	<i>15</i>
2.3.1	Video 1 with graphical element effects .....	15
2.3.2	Video 2 with light effects.....	17
2.3.3	Video 3 with colour effects.....	18
2.4	<i>Interviews .....</i>	<i>19</i>
2.5	<i>Recording of the experiments.....</i>	<i>20</i>
<b>3</b>	<b>Result and analysis .....</b>	<b>21</b>
3.1	<i>Preparations handled before the user testing .....</i>	<i>21</i>
3.2	<i>Attract attention with effects .....</i>	<i>21</i>
3.2.1	Comments on the effects.....	22
3.2.2	Combination of effects.....	27
3.3	<i>Section 1 of the user test .....</i>	<i>27</i>
3.4	<i>Expert analysis .....</i>	<i>29</i>
3.5	<i>Results .....</i>	<i>31</i>
3.6	<i>Screen recording.....</i>	<i>34</i>
<b>4</b>	<b>Discussion.....</b>	<b>35</b>
4.1	<i>General discussion .....</i>	<i>35</i>
4.2	<i>Expert discussion.....</i>	<i>36</i>



<b>5</b>	<b>Conclusion.....</b>	<b>38</b>
5.1	<i>Research Questions .....</i>	<i>38</i>
5.2	<i>Future work .....</i>	<i>39</i>
	<b>References .....</b>	<b>40</b>
	<b>Appendices .....</b>	<b>43</b>
	<i>Appendix A Screenshots from the screen recording.....</i>	<i>43</i>
	<i>Appendix B Material from the planning phase before the filming .....</i>	<i>59</i>



## 1 Introduction

In this section of the paper are background, problem definition, research questions, limitations, and related work presented.

### 1.1 Background

*Capture the moment* is a well-known quote and refers mostly to take a photo of something at a unique time and place, but it can also apply to a recording. When recording is made with a 360-degree camera, it literally captures the whole moment. That is one reason why extreme sports, exotic destinations, an experience of the wildlife and different kind of concerts are associated as popular 360° videos (Tang and Fakourfar, 2017). The most common intention with a 360° video is to give the audience an immersive experience where the goal is to make the viewer explore the scene for themselves. The viewer is in the center of the scene and action happens all around (Tang and Fakourfar, 2017). The feeling is like to be at the exact place where the video was filmed which gives a unique experience. This experience is an example of the distinction between a 360° video and a traditional video. The view is also different for the audience when they are watching a conventional video in comparison to an omnidirectional video. Figure 1 and 2 are two different 360° images, the difference is that the view and wideness on figure 1 are similar to a traditional video and figure 2 shows how a 360° video is displayed for the viewers. It shows how much overview the audience has when they watch a traditional made video and how little of the video is shown in a 360° scene.



**Figure 1.** Screenshot from the traditional view in Adobe Premiere Pro.



**Figure 2.** Screenshot from the Toggle VR video display function view in Adobe Premiere Pro.

When watching a traditional video, the audience has an overview of the entire video and only needs to follow the action with their eyes. The audience does not have the same view in a 360° video. The video is set to start at a specific angle of the scene, and from that point, the viewers need to interact with it to get around and see everything. The interaction differs from the device used to watch the 360° video.

A 360-degree video can contain many subjects or objects to look at, like in a concert or a tutorial of some sort. Characters in the video can move fast with the camera by holding it when performing an action sport like freestyle skiing for example. The camera can also be stable on a tripod, and the characters can instead move in front of the camera. It can be hard sometimes to catch everything that is interesting in the video, it all depends on what the theme is. Quick movement is one example of something that is complicated to process Howard and Holcombe (2010). What does catch people's attention then? That is a broad question where many aspects are included. Howard and Holcombe (2010) are writing that moving objects can capture the attention of the viewer. Multiple visual characteristics can emerge to grab attention. For example, the appearance of a new subject or an object among a background of older items and objects can grab attention. Objects in a scene that has a difference in motion can as well direct the attention of an audience. This is a few examples of what people look at, and it comes from their subconscious. The things that can attract people's attention is highly relevant to a 360° video considering to the perspective from it.

### **1.1.1 360-degree video**

A 360-degree video could be considered as a special version of virtual reality (VR) but is associated in other fields like robotics. The viewing of a 360° video differs from a traditional video, which the viewers see a sphere of video centered on a single position according to Sheikh et al. (2017). Depending on which platform is used to watch it, people can do different types of interaction. The perspective on a mobile or tablet can be changed with a simple rotation or dragging with the finger.



On a computer, the perspective changes when dragging the mouse around or using a keyboard.

### 1.1.2 Visual attention and selective visual attention

According to Chen et al. (2017), humans can only concentrate on a few significant items or objects in a complex scene when it comes to the human visual system (HVS). This sort of behavior is called visual attention mechanism. The human's attention is attracted to other humans, colour and high contrast in general.

Research in this field has concluded that bottom-up and top-down mechanisms in visual attention are a two-component framework which is highly relevant. The bottom-up mechanism includes several properties that attract attention in our subconscious. The top-down mechanism contains voluntary control. The observers are biased towards stimuli selecting which belongs to their goals when perceiving a scene (Yan and El-Nasr 2006).

Selective attention is a property among humans and animals' vision, this property allows them to extract information which is important from the abundant visual input perspective. The selective attention exists everywhere. According to Zang and Lin (2013), 70 % of the information from the outside that a human takes in is coming from the visual sense. Humans get a lot of information to the processing subsystems in the brain, but the visual processing system has the most significant role. The information a human perceives is obtained by our five sense organs, and those are skin, nose, ears, eyes, and tongue. The behavior is based on the information people get into their brain. Viewers often think that they can see all the details in a scene. This occurs when the observers are looking at a scene where a blank field implemented between two successive nature scenes. The scenes have subtle differences among them, the observers often fail to spot the changes. The reason they fail to notice the difference is because of the observers' eyes, it can only give their attention and full focus at a given moment in a small area. However, this small area can be seen in detail according to Zang and Lin (2013).

### 1.1.3 Graphical elements, light, and colour

The main components of this work are three types of effects: Graphical elements, light effects, and colour effects. The inspiration comes from different fields where they use different kinds of attention techniques which are relevant to this work, like traditional video, video/console games, and theaters (Dwight, 2016). The four main methods to attract attention in this field are graphical elements, lights, colours, and sound according to Dwight (2016). Sound effects are not going to be a part of this thesis, the reason for that is further described in the Limitation part 1.4.

## 1.2 Problem Definition

There are significant differences in how a viewer watches a traditionally made video in comparison to a 360-degree video. Traditional screen media as we know it is viewed on a rectangular screen. 360-degree videos have no screen edge, the entire scene surrounds the viewer (Dooley, 2017). An example of this can be that the viewer looks at a traditional movie through a window. In an immersive film, the viewer is a part of the scene instead of being a bystander. This gives many problems



to live action content producers, where it is hard to hide lightning rigs and other technical equipment, so it does not appear on the screen for example.

Sheikh et al. (2017) writes that filmmakers have both new opportunities but also challenges with the 360° format. Without the same interaction boundaries as a traditional video, the viewer gets a more realistic feeling of the real life when they are viewing a 360° video. The director of this type of videos is constrained with techniques used in the set and those are often used in traditional video making. The techniques are for example differential focus, different camera angles and cutting between the angles, also moving camera techniques is constrained. These types of techniques are used to tell a story and lead the viewer through a narrative in movies and TV. In a 360° video, techniques like those can give a negative experience for the viewer. The audience can feel that they are less of control (Sheikh et al., 2017). Since the viewer's control of their own gaze is a benefit in these types of videos the director needs to let the viewer have it and make techniques that are more refined and unobtrusive. The fundamental methods of how to attract attention have started to be explored, this is made by using different types of cues, for example, lightning and movement.

According to Neng and Chambel (2010), it is a lot of information to embrace for the viewer in a traditional video and this information changes along the time. It is safe to say that it is even more information to handle in a 360° video and it becomes a challenge for the viewer because they cannot look around at two or more angles of the video at the same time. The information given in the video can be crucial, and it can provide the whole picture or story for the audience watching the video.

It is challenging to control the viewers and make them see all the essential things the creators want them to see, and at the same time preserve their freedom of interaction and control of the video. This study will explore the opportunities of attracting the audience attention to specific elements or objects in three videos using colours, lights and graphical elements. This can give creators a better understanding of how they can direct the viewers' attention towards something significant.

### 1.3 Research Questions

**1.** How can one attract the viewer's attention to specific elements in a 360-degree video?

**1.1** What is currently done to attract viewers' attention in videos and immersive environments?

**2.** How could light, graphical elements and colour be used to attract viewers' attention in a 360-degree video?

**2.1** Which element is the most suitable?



## 1.4 Limitations

To attract attention in a video can different types of techniques be used in several parts of video production. It can be used in the set during the filming, but it can also be used in the post-production. This study is going to cover the post-production part and not during filming on set. Virtual Reality headsets is a common association with 360° videos, but it is not a part of this work. The computer is the only platform being used, mobile devices such as smartphones and tablets are not a part of it. The sound is often a part of attracting attention but requires different types of recording techniques and equipment to be able to use it in the post-production part. This was not possible because of the limited resources. Therefore, sound methods are not going to be covered in this study. The three techniques colour, graphical elements, and lights are going to be made separately. Combination of these techniques is something that can be explored in further work, but in this study the first step is to see which video effect is the most suitable separately.

## 1.5 Related Work

### 1.5.1 Techniques used in a set to direct attention in a 360-degree video

Sheikh et al. (2017) presents their work about directing attention. One of their research questions is significant for this work: “What attracts attention, what refocuses attention, and what techniques can a filmmaker use to direct the attention of a viewer?”. It is about what attracts and refocuses attention, and what kinds of techniques can be used by a movie maker to direct the viewer's attention. The differences with this specific work are the focus of the filming part in video production and how it can attract attention. The present study is about post-production which is the last part of the process of video production. They filmed four 360-degree videos and shot it in a particular way to demonstrate several techniques that can be used for directing a viewer's attention. Participants in the user study watched the videos with a head-mounted display. The methods used in this study were concentrated on what can be used in front of the camera with actors. There were two main characters in each video and cues or signals were used to attract attention towards something. An example of a cue is: “Bystander walks to target, waving.”. This was a gestural cue used in one of the videos. It was two kinds of signals, one of them were visual cues in this one is gestural cues included, and the second signal is audio cues. A person shouting a name is an example of the audio signals they used. This study concluded that audio and the visual cue were more effective together than visual cues lonely. This indicates that a complementary to visual cues is required and this is something that is going to be considered in the present work.

### 1.5.2 Heatmaps functionality in a 360-degree video

YouTube has a tool where the creator can see heatmaps for their 360-degree videos and VR videos according to Creator Blog (2017). The heatmaps are there to see the precise angles and parts of the video that catches the audience attention and also



how long time they looked at it. They have researched that people are spending 75 % of their time looking at 90 degrees of the content in the video (Creator Blog, 2017). With that said it is important to spend time in front of the viewers. The more eye-catching an entire scene is, the more chance it is that the viewer will explore the whole 360-degree view. Different kinds of animation and markers can be used to draw attention on an angle or a specific part of the video.

For this current paper is the 90 degrees a challenge. The intention is to make the users look at the angle where the video effects are appearing. Where the users are watching when an effect is occurring is hard to predict, they can be positioned between 0 to 180 degrees from the important section. Besides that, the effects in a video are appearing in the range of approximately 90 degrees from each other.

### **1.5.3 Draw attention with visual methods**

Brillhart (2016) points out that cues can be added in a 360-degree video to get the viewers' attention. Examples of cues or signals are animations and a colour shift. Cues are used in multiple mediums for different kinds of purposes. They can be used to create attention spots and strengthen the pre-existing points of interest to amplify the experience the viewer is going to have. The more visible a cue is, the more likely a viewer will draw their attention to it but at the same time less immersed will the viewer feel. It works the same way around, the less visible a cue is, the more likely a viewer will feel that it is normal which is the purpose and goal. The downside is that the viewer will less likely catch and engage with the cue.

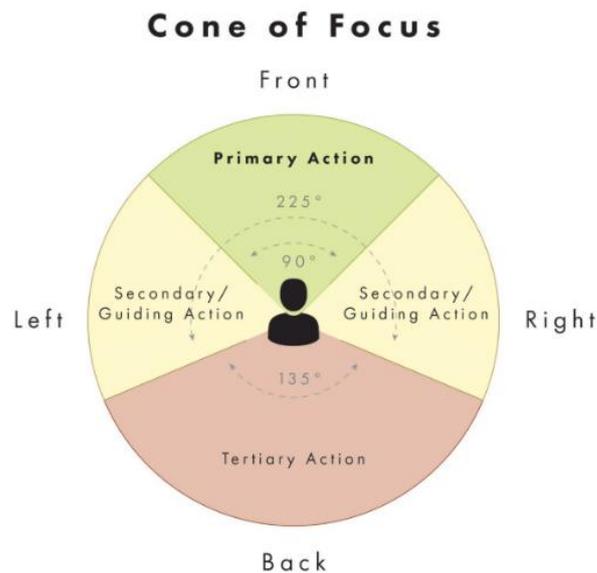
The usage of cues is inspiring both for the visual purpose but also for the psychological meaning behind them. The current paper will make noticeable effects in the same way the cues are meant to work but in a more balanced approach. If they are too prominent and visible, the viewers will mainly focus on them and will not be able to concentrate on the rest of the scene. The effects cannot be less noticeable either, that is why balance is necessary and finding a middle ground to it.

### **1.5.4 Directing audience attention in 360-degree videos**

VR has an expression called "convergence medium", this means that multiple art forms merge into a single medium according to Dwight (2016). The best 360-degree storytelling is not inspired by the traditional film. Instead it comes from two different mediums in the form of video games and theaters. The reason is that conventional film implies controlling and navigating the audience attention. In movies, they are framing the object or subject they want the audience to see. Directors for 360-degree videos and VR does not have the same control. 360-degree storytelling is about to let the viewer explore the scene. Video games have an essential form of the environmental storytelling called level design. A game designer uses colour, sound, and lightning in games where the user can move around freely to attract attention. Theaters are using sound cues, lighting and stage setup to control the audience attention. The same techniques used in video games and theaters can be applied to 360-degree videos to direct the viewer's gaze and



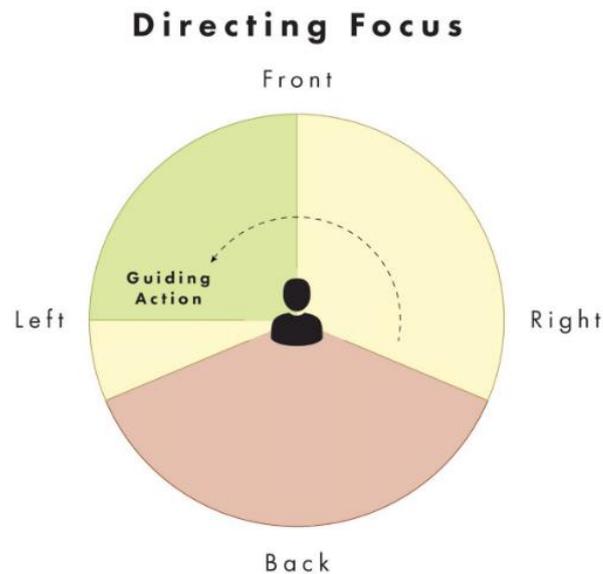
shift their focus. Dwight (2016) points out that the cone of focus is divided into three categories, primary action, secondary action and tertiary action. Figure 3 shows an image which illustrates how the cone of focus works. The primary action is where the essential story is concentrated for the longest of time. The start of the storytelling should begin in the primary action, in front of the viewers. The secondary action is supporting the story's interest, it is not essential but gives a context to the video. The tertiary action keeps the viewers immersed and is not as important as the primary and secondary action.



**Figure 3.** Cone of Focus (Dwight, 2016).

A viewer manages 90-degrees of the field in the primary action mostly, as can be seen in figure 3. Using techniques like cues can extend the viewing field as figure 4 is showing. Sudden and dramatic changes in lighting, sound, or action in secondary space will attract the viewer towards that specific direction (Dwight, 2016). This technique can give the secondary and tertiary action a meaning and can redirect the primary action to a new direction.

In the current paper, the 360-videos are made in consideration of the primary, secondary and tertiary action. The video starts with the primary action as Dwight (2016) explains it, is the most effective start. The area of the secondary action is slowly being involved. The video starts exactly on the same side as figure 3 is showing. The primary action is turning to the other side of the location after a while and is concentrated there for the rest of the video. To visualize it think that figure 3 is rotated 180 degrees. The only changes of position in the video are in the primary and tertiary action, they change the opposite side of each other. The second action is on the same area along the video.



**Figure 4.** Directing Focus (Dwight, 2016).

Directing focus is also a relevant part of the current paper. According to Dwight (2016) sudden types of cues like lightning change the direction of a viewer's spectrum and draw attention towards a specific angle or direction in the scene. Example of cues can be lightning. The current paper has different kinds of visual effects that are sudden and occurs in different ways and at a different speed. The effects are made to guide the audience through the video and make them look at important objects or subjects to make them understand the video fully.

### **1.5.5 Storytelling and its role in a 360-degree video**

The aspect of attracting a VR viewer's attention is one of the most important considerations for a director and writer according to Dooley (2017). A traditional filmmaker uses a conventional screen media, a rectangular frame where edit points and some close-up shots can be used to attract attention to a specific object or subject. For a viewer watching a VR video, the field is more extensive to explore than a rectangular frame. The environment of a 360-degree field gives the viewer a lot more freedom to explore, but therefore can they ignore the directors/writers story. Dooley (2017) points out that the creator of a video cannot be guaranteed to have control of the direction towards an angle where the viewer will look. One suggestion that can help is to spread out the action over the entire video instead of having it on just one part. Attention is working like a zoom lens on a camera or a spotlight and improves when it directs to a specific location. To attract the viewers' attention in a useful way bright colours, loud sound, and a sudden flash of light can be used.

The present study is embracing some techniques that Dooley suggests. A spotlight is made and directs the audience to a specific angle of the scene. Colour effects are



also used to draw attention to a particular section. Other sorts of video effects are also made to attract attention. Effects of different kinds are helpful to use when a director has limited techniques to choose on and an entire scene to cover.

### **1.5.6 Robot navigation with spherical images**

Ran et al. (2017) are proposing a framework for robot navigation based on spherical images. This is made to handle the drawbacks of the testing and the training phase in an algorithm. Example of drawbacks in a training phase can be the complexity of high-quality label collections. During the testing phase, it can be the complexity in intense computational instead. A spherical camera is used to get a 360° fisheye panorama of the scene. This eliminates the limitations on available steering choices. Ran et al. (2017) are proposing a framework based on 360° fisheye panoramas. The spherical images in the framework would be useful in the training and navigation part. The robot navigation framework is tested to formulate and to accurately estimate the heading direction for the robot with the help of raw spherical images. The 360° images of the scene cover all possible heading directions even the wrong ones. The training and navigation part are similar to this present work with a tutorial and a sort of navigation. To identify the region of interests is a common concern. One thing that is not similar is the approach in the method, in this current work is the users' function to provide data instead of an algorithm in a framework.

### **1.5.7 Regions of interest in an omnidirectional image**

Omnidirectional images can be used in many ways, and they contain the entire perspective of a scene. This kind of images can give a specific description of the colour from all directions in the scene. The perspective provides a new exciting way to view images or videos. One image contains both exciting parts and parts that are not as interesting. This differs from user to user, some users like one part of an image and others like another part better. To identify these regions of interest can be helpful considering the different ways a 360° image can be used, like streaming, editing, and compression according to Maugey et al. (2017). It is a difference in watching a 360° image and a regular 2D image which is the most common one. An omnidirectional image is not meant to be viewed entirely to see everything on it directly, unlike a traditional 2D image it is intended to be explored. The user can choose which part of the frame the projected image will show. This means indirect that some part can be left out and not seen at all or just seen for a short sequence of time. This work addresses the issue on how parts of a 360° video are viewed more of some users, and another part of the same video is viewed more of some other users. The parts are called regions of interest and the method used is saliency estimation to figure that out. The saliency estimation will be developed in the context of a 2D image and how it can be used for 360° data (Maugey et al., 2017). It is interesting to see the relation between traditional 2D imaging and 360° data and videos. However, this current study will only focus on the 360° video and not images. Instead of estimation with algorithms, it will be video effects drawing attention to a particular side of a scene. This will show which region of interests the



users are attracted by and how a director can take the region of interests to their own hands.

### **1.5.8 Design challenges in 360-degree videos and game world design**

Argyriou et al. (2016) propose new design challenges that can work for gamified interactive 360-degree videos for example. In this way, the user can be more involved and engaged in the video. The study will show architecture and a process for making an application which includes game elements in an interactive design process. Examples of game elements are badges, time pressure challenges, and storytelling narrative. This study focuses on 360-degree videos combined with game techniques. One experience the user is going to have is following different kinds of subplots, this will lead either to success or failure in the game story. This is also known as branching narrative and is used to attract user's attention and also to make the game world more realistic and believable. Argyriou et al. (2016) are writing that the most vital matter is not having visual cues in the game world like tutorial messages or distractive notifications for example.

The present study consists of a 360-degree tutorial video with effects and text to inform the user. It is also essential to have tutorial messages to instruct the users, but in the same way not to disrupt them from the current experience of the video like Argyriou et al. are doing in their game world. Concerns like position, size and how long a badge or other elements will be displayed in the scene or in the interface are the interest of both studies.

### **1.5.9 Visual attention guided eye movements for 360-degree images**

Traditional 2D images are the most familiar images people use and has been a standard for a long time. That is why visual attention within computational models for navigating eye movement is mostly used in 2D images. That is also the reason most of the traditional models are not suited for 360-degree images according to Li et al. (2017). Humans are choosing to concentrate their vision on parts of an image with abundant information. Based on that information, this study is proposing a novel approach to viewing 360-degree images in a sense to stimulate and analyze the scan paths of human eye movements.

The present study is showing where the users looked at in a particular side of a scene in the user tests when certain effects appeared. This was done with the help of screenshots. It can be seen in Appendix A. It is the same thought process as the study Li et al. has done but at a more fundamental level. The screenshots and eye movement are just a small part of the present study in contrast to this work were the authors only focusing on scan-paths and eye movements. Another differentially is that the present research is focusing on user testing. To estimate the attention on human visual attention navigated eye movements when it comes to 360-degree images a computational model is used Li et al. (2017).



## 1.5.10 Prediction of activity in a 360-degree scene

Zhu et al. (2018) are describing three types of approaches that are analyzed and completed to collect data in the paper. The method used consists of viewers watching 360-degree images in a Head Mounted Display (HMD). The three types of approaches are head movement data that can be seen as the movement of the viewport. Head-eye motion data, which also is involved in the viewport and combines the motion of a person's head along with the movement of an eye. The third one is scan-paths data from users, they observe the images, and information on time and position is being recorded. Zhu et al. (2018) are explaining that the head movement and head-eye motions saliency maps are predicted by a model. The same model is also anticipating the scan-paths. The prediction can be an important task to do and can contribute to attracting people's visual attention. When it comes to the 360-degree field, both videos and images are recorded to get the full spectrum of a scene. The final 360-degree product does not show the entire spectrum when viewers are watching it. They can only see a part of the location in the viewport. Without the prediction, it would render a whole scene, send it out to the public, and be considered as a waste of resources. Instead, the focus can be on stream or render a scene in the field of view where the audience would probably look at. An algorithm is included in the model which predicts the areas in a scene.

The idea to see and predicts areas with higher and lower activity is interesting. This is made with an algorithm in a pre-recorded 360-degree video. However, the current paper does not predict where the viewers will look at in the 360-degree video like in Zhu et al. study. The effects will help to draw users' attention to a particular area in a scene. The conclusion of it is always to know where viewers will look. Something both studies has in common is the issues. Zhu et al. (2018) are talking about a video with full access to see the entire scene but in the same time are the viewers limited to see one angle at a time in the scene through the viewport. This is the same issue the current paper has, that makes it harder to predict and also to be sure that the viewers are going to see a specific angle of the location.

## 1.5.11 Video game concepts used in a virtual environment

VR and 360-degree videos increase every day and are more frequent in both learning and education tasks. Video games are a medium that is appreciated as entertainment. According to Murias et al. (2016), a computerized task similar to video games is now used more often in research and other fields. This study has shown how people's performance in video games is compared to it in virtual environments tasks. In this study has orientation and navigation-based tasks been conducted. It showed that people with a long experience of video games had better performance on a navigation task performed in a virtual environment. The reason for those results is that people with a long history of navigational video games have further cognitive thinking with maps and has learned some paths through the game. This study shows that people playing solo video games gets better navigation and topographical experience if they are consistent and often plays in the purpose of entertain themselves (Murias et al., 2016).



It is fascinating that people who are used to navigating in video games are transferring this experience to the virtual environment. Dwight (2016) is writing about 360-degree storytelling and how it is inspired by two other mediums than traditional film, those are video games and theaters. This proves that video game is definitely one medium that can be compared to 360-degree videos and how strong it can be connected to it. The present work is inspired by video games and how they are attracting attention towards some section.

### **1.5.12 The FOV in a 2D display compared to an omnidirectional space**

The field of view (FOV) has been seen as a limitation in video communication systems for a long time according to Zhengqing et al. (2018). This same issue includes in a 360-degree video where the field of view of the scene is narrow. Despite that, a 360-degree video can offer a view of an entire scene with interaction, and this is one reason why it has become popular. In this study has a spherical display in an omnidirectional camera and a 2D flat display placed horizontally been included in the experiments. The result showed that the users favored the 2D flat display which had a spherical display attached to it. This study can contribute to understanding the comprehension of how the design process for remote collaboration including the capturing and demonstrating of a remote site with a 360-degree view. Furthermore, this present study presents a full panoramic field, and some of the methods could not work on a flat 2D video. The audience is often more curious of a spherical space than flat and that can both studies show.

### **1.5.13 Subtitles used in a 360-degree video**

Right now, there exists no guidance that is agreed-on for user experience when it comes to subtitles in 360-degree videos (Brown et al., 2017). This can make the audience confused when a subtitle is displayed. It needs a sort of balance when it comes to the freedom of looking around a scene, comprehension and immersion. In this study are four subtitle methods designed and presented to the users. The methods are 120-degree, Static-Follow, Lag-Follow and Appear. The 120-degree methods provide subtitles placed in three directions. They are placed around the center, 120-degrees from each other and in the study, it is at 0°, 120°, and 240°. The Static-Follow as a head-up display (HUD) and that is fixed in front of the viewer through the entire video. The Lag-Follow takes the sickness away which the HUD can create and keeps the subtitle where the viewer can see it at any point. The Appear method is created after feedback from the Lag-Follow method. The subtitle is placed at the center and 15° below the viewers' eyes. When the viewers are moving their head, the subtitle does not follow them and stays static in the scene.

This study is inspiring to the present study. The subtitle is similar to the text used in the text in a box effect showed in the graphical elements video. How it should be appeared and presented is a consideration for both studies. The subtitles are displayed a lot more through the video than the text in the box where the effect only occurs in some parts of the video and can be placed strategically.



## 2 Method

In this part will appropriate methods for the research be presented. The planning, filming and the post-production part of the 360-degree videos are also part of it. Questions from the interviews and methods used during the interviews are described at the end.

### 2.1 Description of methods and how to implement them

The comparison group approach was implemented in this research. This approach allows a comparison between the three 360-degree videos and in the end determine which video is the closest to the goals. The method lets the outcome of the video be compared to how each group of users responded to it (Clinks, n.d.). The groups in this paper handle the same three videos but not in the same order. The data outcome can because of that be different from what each group and users respond. The groups and users do get to watch and interact with the 360-degree videos, and that is their only task in each video. Clinks (n.d.) explains that the studies of the comparison group should not be seen as a replacement for other methods of qualitative research. The approach should be seen as a complement to provide evidence of influence. That is why an interview is conducted after the user tests.

One 360-degree video was filmed and later edited to three different versions. The theme of the video is a broadcast tutorial on how to set it up. The theme has no significance for the research but is chosen to have something to implement the ideas on. The experiment will be divided into three groups, and every group is going to have one main video to focus on. The participants main video is determined after which order they are contributing in. The participants 1, 4, 7, 10, 13 had the graphical element as the main video. The participants 2, 5, 8, 11, 14 started with the light video and 3, 6, 9, 12, 15 watched the colour video first. The reason for the three groups is because it is three videos. The users are going to see all the videos to get an opinion on them as well. However, the test will be conducted with one person at a time. The user tests are executed in a controlled environment with a computer, computer mouse and headphones, the keyboard had no function. The computer mouse is the only equipment to interact in the video.

The test is divided into two parts, in the first part the user is watching the main video. When the first video is finished, a semi-structured interview is conducted with specific questions about it. Questions regarding how every individual effect is attracting the attention on a Likert scale 1 to 5. The number 1 represents strongly disagree and strongly agree will be a 5. Number 2 stands for disagreeing, and number 4 stands for agreeing. The number 3 is the middle ground and indicates that the participants are not agreeing but also not disagreeing. According to Robson and McCartan (2016) are five fixed alternative expressions on a Likert scale the most common form. Questions on how all the effects in a single video attracted their attention in the video and general opinions about them are also included. The goal is to get as many comments about attracting attention as possible. The users are watching the two other videos in a row in section two of the user test. An interview is conducted with specific questions about every individual effect after they have watched the videos. Section two provides general questions which are asked, and



they are often linked to each other. A general question will be if they think that their preferred effects would work more effectively together as a combination. The last question address if some information or other things are missing in the video, and comments in general where they can say what they want about the video. Specifics regarding the semi-structured interview are explained in the Interview part 2.4.

To answer research question 1 and 1.1 a literature study was done, this section is called Related work and presents the results in depth.

## 2.2 Implementing the 360-degree videos

The theme of the video was a tutorial on how to prepare and how to set up for a broadcast. A required list of items for filming was made, a script and a sketch were all part of the planning. Owens and Millerson (2012) mention the importance of a script before filming to coordinate with the rest of the team in the production. It also helps the director to assess the resources that need to be included in the set. One thing that was important to plan is the positioning of the 360° camera. Positioning the camera in the middle of the room was important. The purpose of the position is to get a better overview of the entire room for the viewer, and it makes them interact more like rotating around to see the action for example. The original colour on the table at the left in figure 5 is red, but a white paper was applied to it, and the red was not visible during the filming. The main reason for that is to not interfere with the red circles on the colour video. Another reason is that the red colour is a noticeable one and attracts attention; therefore, the viewer may look at it more than other parts of the video (Samara, 2014). This specific table appears in the hot spot many times during the video, and some devices and connections were made there.



**Figure 5.** The set with a white table at the left instead of a red colour.

The script is of the sort single-column format, that means, all the information about the video is in a single main column (Owens and Millerson, 2012). The script was made to explain and show the viewers how to set up a broadcast in the most effective way. The actors are showing the equipment used in a broadcast and how to



connect them. The script leaves some space for the actors to improvise, it may sound more natural in this way and not entirely staged. The actor's native language is Swedish, but the script is written in English which creates the entire video in the same language so that a broader audience can understand it. The script and the performance from the actors in the video were created to make it more difficult than necessary for the users. In one case, two situations appear simultaneously, one event more of importance for the user to see and one which has no significance for the actual learning. This is made to see whether video effects can counteract the concentration difficulties and allow the audience to focus and give their full attention to a particular angle. Two realistic scenarios that can happen are concentration difficulties and that something unexpected is occurring in a 360-degree video, it is important to see how it can be managed. The video is a bit longer than necessary because of all the important functionality and other techniques required to fit in the video. The script can be found in Appendix B.

The map is illustrating the location and can be seen in Appendix B as well, it shows the actors starting position. It also presents the final positions of the equipment. This map gives an overview of where the actors will start the filming and how everything will be placed. The script is also shown in Appendix B and tells the actors what to do between those moments.

## 2.3 The post-production of the 360-degree videos

The video effects are based on literature in the Related work, and some of the effects are inspired from other sources like YouTube for example. The videos are stitched with Kolor Autopano<sup>1</sup>, they are edited in the software Adobe Premiere Pro<sup>2</sup> and After Effects<sup>3</sup>. Premiere Pro is the main program used for editing the videos, both cuts and effects were made there. The main reason for the choice of the program was the ability to edit 360-degree videos, and Premiere Pro has several features<sup>4</sup>. After Effects was mainly used to apply effects on the videos.

### 2.3.1 Video 1 with graphical element effects<sup>5</sup>

- Text in a box
- Call out titles
- Guiding lines

---

<sup>1</sup> <http://www.kolor.com/autopano/>

<sup>2</sup> <https://www.adobe.com/ca/products/premiere.html>

<sup>3</sup> <https://www.adobe.com/ca/products/aftereffects.html>

<sup>4</sup> <https://helpx.adobe.com/premiere-pro/using/VRSupport.html>

<sup>5</sup> [https://youtu.be/wrUfspeCh\\_I](https://youtu.be/wrUfspeCh_I)



**Figure 6.** The video effects text in a box and call out titles during the graphical elements video.



**Figure 7.** The video effects call out title and guiding line during the graphical elements video.

Call out titles are appearing on every equipment used in the broadcast. The actors who set up the broadcast is telling the name of every object and information about them and what their function is. The call out title is complementary to it. This is also what the text in the boxes do. It repeats what the actors are saying and can be useful if the viewer did not hear a particular part.

The lines are animated, and they guide towards something important. They start at the other end of the room in the video and move all the way to the important part. If a viewer is looking at another way, they will have a chance to see the lines. The inspiration for the lines came from a video the New York Times made about Petra, one of the seven wonders of the world<sup>6</sup>.

---

<sup>6</sup> <https://www.youtube.com/watch?v=I3W1kyp9Jpc>



### 2.3.2 Video 2 with light effects<sup>7</sup>

- Spotlight
- Light and dark areas



**Figure 8.** The video effect dark and light during the light video, the important action occurs on the light side.



**Figure 9.** The video effect spotlight during the light video, the lighter part is the important area.

The effects in the light video tears on the boundaries. They are all about darkness and lightness. When something significant occurs, it becomes dark around that section in the video (see figure 8). It is not entirely dark though; the viewers can still see what happens around them, but the view is limited. When an item is about to be connected, or a new item is shown, a spotlight appears on it and the rest of the video becomes dark. Spotlight can be used visually in the same way as in a theatre. A video can be made with darkness where the less important information is concentrated, and a more important area can be highlighted with the colours light yellow or white as a spotlight shape according to Malamed (2015). Theaters are using stage light to highlight something essential and guide their audience (Dwight,

<sup>7</sup> <https://youtu.be/LeB-wEMCGdQ>



2016). The viewers' freedom becomes less important in this video, and the point of it is to see how the viewer responds and feel about this experience.

### 2.3.3 Video 3 with colour effects<sup>8</sup>

- Red circles
- Cold and warm colour grading



**Figure 10.** The effects red circle and warm/cold during the colour video. The area with warm colours and specifically the red circles is the most important for the viewers to see.

Malamed (2015) is writing that colour is an element used to grab attention. When for example bright colours are used as a signal of importance, viewers sort out all the extra information there is and shows where to draw their attention. A way to attract attention to an important area is a change in colour. A change in colour is an essential aspect of animations. This can be useful to highlight relevant information, animations that goes to fast can be missed otherwise.

According to Samara (2014), red colour stimulates the human brain and more specifically the autonomic nervous system. This makes people invoke the fight-or-flight response, and that is connected to adrenaline. It makes people feel more passion and more impulsive. Red is also a vibrant colour and is considered to be one of the most noticeable ones. This is the reason why red was picked to be a part of the colour video. Red is the only colour used besides the warm and cold colours.

The red circles signal that something important is about to happen in the video. The circle appears and blinks three times before it disappears. The blink is a sudden action and can, therefore, attract attention to an important part. Franconeri et al. (2005) point out that various heuristics in the visual system are used to direct the attention of the viewer towards important locations and objects. Sudden alterations

---

<sup>8</sup> <https://youtu.be/wt1UK5dfvi8>



in the environment can direct the attention. The red circles are used as a complement to the warm colour.

Cold grading and warm grading colours are also used to attract attention. This effect is used similarly as the light video. The warm colour is used to draw attention to an important part. Yan and El-Nasr (2006) provides an example when people observe a green bush, with a red rose in it, the subconscious will automatically attract the attention towards the red rose. This is because of two reasons, the first is that the colour red is a warm colour and the green is a cold one. The second reason is the contrast of both colours (Yan and El-Nasr, 2006). This example can apply to the colour video, the warm colour in this video represents the red rose, and the rest of the video has a cold colour and represents the green bush.

## 2.4 Interviews

The interviewee had a topic and questions to ask, and they were not always in order. Some questions were asked to follow up on answers also. It was hard to plan what they were going to say; therefore, those questions are hard to prepare and become more spontaneous. The order of them in a semi-structured interview can be modified based on the flow of the interview (Robson and McCartan, 2016).

The participants watched all three videos. They did get a first experience of the theme in the first video, and they knew what it was about after that. They did not know which effects would appear in the upcoming videos. Therefore, semi-structured interviews were conducted after the first video and after the last two videos. With the type semi-structured the participants can speak more freely, but in the same time, the interviewer has some control left, and that is why it is chosen to this work (Robson and McCartan, 2016). Voice recording of the interviews is a part of the study. The voice recording is transcribed to text afterward. The advantage of the recording is that the tape is permanent and allows the person conducting the test to concentrate on leading the interview according to Robson and McCartan (2016). The interviews are going to provide details of the video from the participant's view. This is the list of questions after the first video:

- What is your opinion on the graphical element/light/colour effects?
- The effects in the video helped me to get a better understanding of the video 1. Strongly disagree - 5. Strongly agree?
- The effects attracted my attention 1-5?
- The effects distracted me from the content of the video 1-5?
- What kind of effects or objects would you like to see in the video to help you observe the most important action at a specific time?
- Could you rate the effects individually 1-5 based on how they helped you to grab the attention?



This is the question after they watched the two last videos:

- Could you rate the effects individually 1-5 on how they helped you to grab the attention?
- I see that you preferred “this effect”, why is that?
- Do you feel that the effects in the videos you preferred were efficient?
- Do you think the preferred effects would work as a combination in a video?
- In the light and colour video, the text was also used to explain when some connections were made, and the talent did not mention it. Did you notice the text?
- If you answered yes, can you answer this statement: this information was useful to me 1-5?
- Where there any effects missing in the videos?
- What kind of information do you think will be beneficial in the video?

## 2.5 Recording of the experiments

Every video is going to be screen recorded to see where the users are looking. A screenshot will be taken at a specific time in the video on all the user tests and be compared. This is going to tell if the effects are attracting to a section of the video. Another reason for the recording is that the moderator of the test needs to be aware of what the participant does all the time. The moderator should not interfere with direct observation, and that is one of the purposes of a recording (Rubin and Chisnell, 2008).



### 3 Result and analysis

In this section can results of the user tests be found, and analysis of it. Participants comments on their experience during the videos is also a part of the chapter. The section ends with thoughts from an expert in the field who also participated in a user test.

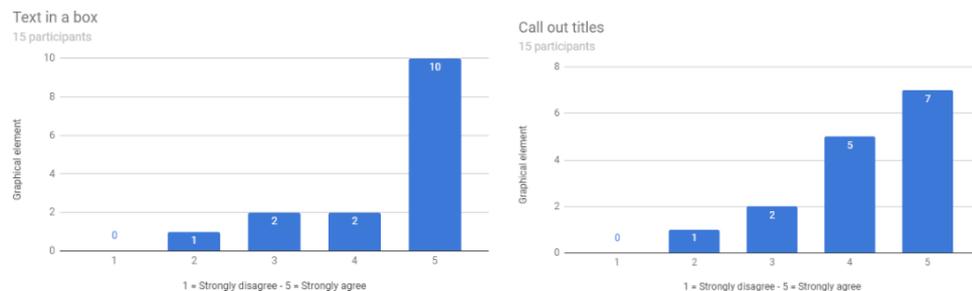
#### 3.1 Preparations handled before the user testing

15 sessions with one participant at the time was done. An expert session was also conducted. The participants were told that they would look at three 360-degree videos about a tutorial on how to set up a broadcast. They were not told that it is going to appear effects which are supposedly going to draw their attention. Because if they knew that it is going to appear some video effects, they would have a different approach to them. The first reaction to the effects was important, and further research in the future can do experiments with information in the beginning. 360-degree videos are all about the freedom of exploring a scene. With the information that they should look at some certain effects could interfere with their freedom. The participants looked through the videos without pausing or the observer interrupting. Watching the video required full attention towards it.

#### 3.2 Attract attention with effects

Figure 11-14 shows the users ratings in bar charts collected from a question that was answered on a Likert scale regarding all the video effects individually. This gives a more precise data. The ratings and comments were collected from both section 1 and 2 of the user tests. The question asked: Could you rate the effects individually 1-5 on how they helped you to grab the attention? 1 represents strongly disagree, and 5 strongly agree. 2 stands for disagreeing, and 4 stands for agreeing. 3 is neutral and are not either agreeing or disagreeing with a statement.

The spotlight was the most preferred effect, and the warm/cold colour effect was the least preferable one. Where the users looked at exactly when some of the effects appeared can be seen in Appendix A.



**Figure 11.** (Left) Text in a box effect used in the graphical element video; (Right) The call out titles effect used in the graphical element video.

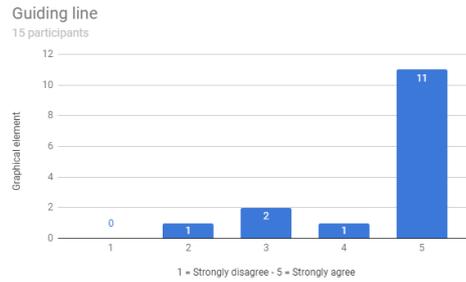


Figure 12. Guiding line effect used in the graphical element video.

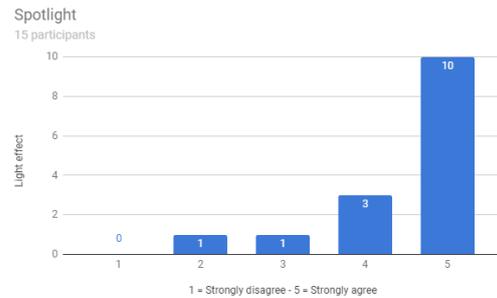
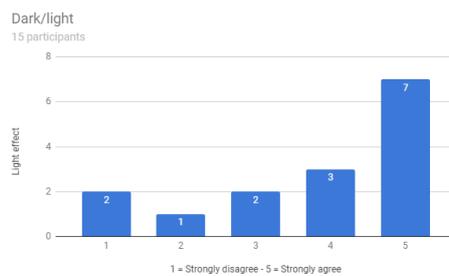


Figure 13. (Left) Dark/light effect used in the light video.; (Right) Spotlight effect used in the light video.

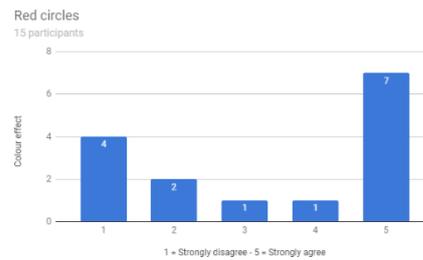
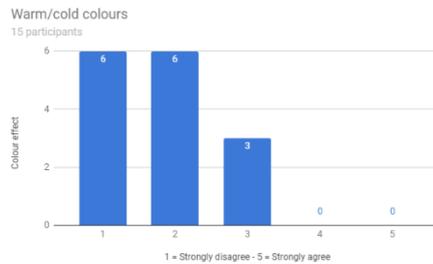


Figure 14. (Left) Warm/cold colours effect used in the colour video; (Right) Red circles effect used in the colour video.

### 3.2.1 Comments on the effects

Most of the users gave comments concerning the effects after they rated them against a Likert scale. Figure 11-14 shows the ratings on the video effects and the comments are in the same order. The comments are mostly about the improvement of the effects and not why they get the ratings they got.

#### Text in a box:

- Do it clearer. Scale it up.
- Not so obvious, if I looked at another way I would miss it.
- It would be hard to notice it if I looked at an opposite way, but the effect overall is clean and practical. It helps me to get basic knowledge.
- It was hard to know where I should look in the video but when the text box appeared, I knew immediately.



- They do not mention all the details in the video, so I find the text in the box useful.
- It is the same concept as the red circle. If I know that the box is going to be at a particular angle, it helps a lot. It is not drawing attention entirely, but I know that something is happening when it appears.
- If I am not looking in that direction, it can be hard to notice it. But when I am looking at that way, and the animation is appearing I know that I should look there.

### **Call out titles:**

- It's a bit confusing.
- They helped to understand what the objects are, but they did not help me to look at a specific angle. But they did show useful information.
- Same situation as the text in a box effect, hard to know about it if a person was not looking at that direction on the exact side. The effect had the information needed, and that was satisfying. If you have the lack of knowledge or not understanding the video, this is helpful to have. It shows precisely what the purpose of an object is.
- Without this, I would not know where to look at specifically.
- It was good to know where you connect the cables and how.
- They helped a little bit, but same as the text in a box effect it is hard to notice it if you are turned at the opposite way. In combination with the lines, it was sufficient.
- If someone did not hear what the actors said it is good to have this sort of effects.
- If I am not looking in that direction, it can be hard to notice it. But when I am looking at that section, and the animation is coming I know that I should look there.

### **Guiding line:**

- It is a 5 when I found the line.
- It showed that I should look at the opposite way, so I followed it to the side with the most activity.
- I did not understand it immediately, I thought that something was supposed to appear between the tripod and the other part with the equipment, some sort of connection between them. An arrow would be much efficient to have. Four arrows in each direction so I know where to look at in any angle of the video.



- I think the effects work best together. I don't believe that either the text in a box and the guiding line would be effective alone without each other. The line helped to look at a direction, and the text in a box helped to keep looking at that specific way.
- This effect is perfect because you are not trapped inside something like the dark/light effect. I could just look around, and when the lines appear, I know where I'm supposed to look.
- It was obvious where to look. It directed me to the right direction. The line was noticeable, and when I saw it, I just followed it. A line is distinct, but with an arrow, it can be more guaranteed to be seen.
- It is not noticeable as a big box with text for example. The good part was that I looked at the opposite way of the action and the line guided me to the right side. An improvement would be to make an arrow instead of a line and scale it up to improve the efficiency.
- I was curious where the line was going so I followed it.
- I followed the line all the way from one part to another. It was a helpful way to show where I should look at.
- It shows precisely where to look.
- It really helped a lot. It was a good combination with text.

## **Dark/light:**

- It is much better than the warm and cold colours. The dark part can even be more shaded.
- It was obvious to look at the lighter part when it was dark in one place, and lighter in another. I was a bit unsure where to look at the first time I saw the dark/light effect. But then I understood that it was the lighter part I should look at. After I realized that I could understand the other upcoming effects.
- I did not understand the video effects at first, that the purpose was to look at the lighter side of the video. In the previous video, it was warmer colours I should look at, so I got confused at first.
- If it were some information at the beginning where it describes that I should look at the lighter side of the video, it would be more helpful.
- When the dark appeared, I felt that I should look after a light part. The attention was drawn to the light.
- The dark/light effect is more understandable, for example, what you should look at compared to the warm/cold colours. I was positioned between the dark and the light, so I knew that I should look at the light side. If I only looked at the dark part without seeing the light, I would maybe not know where to look.



- When it became dark, I knew that I should look at the other way. I turned to the light side where I have a clear sight.
- It was more helpful than the warm/cold colours. It is also understandable that I should look at the light part instead of the dark.
- I noticed a difference between the light and the dark part. It made it more evident on where to look at compared to the warm/cold colour.

**Spotlight:**

- I think the spotlight is on point, it is ideal. It is just one thing; the shape of the spotlight draws too much attention. The best thing would be just to have a circle.
- I thought it was much more effective than the red circles.
- The effect does what it supposed to do, but the lines in the video with graphical elements were more understandable than this.
- It was clear to me where I should look.
- I knew that I should look at something, but I was not sure what it was. The spotlight is small, so it was not straightforward, and it was hard to find it. But when I saw the spotlight, it was helpful. It would be more comfortable with a line that goes to the spotlight, so I know exactly where I should look at.
- Everything became dark here, so I searched for the light part in the same way as the dark/light effect.
- Some people will focus on what they are holding in the video rather than trying to listen to what they are saying. That is why a spotlight is better to have and also a little bit of text in some parts.
- An arrow pointing to it can be a more effective clarification.
- The spotlight was helpful. I knew where I should look at. If I am turned in the other direction, it can be hard to turn all the way to find the spotlight. Besides that, it really does what it should do.
- This effect attracted my attention. You look inside of the spotlight, and it becomes evident on what is happening in it.

**Warm/cold colours:**

- I was not sure where to look.
- Not understandable at all. I thought it was just the colour in the video that changed not that it had a specific purpose.
- I did not understand the warm/cold effect. I did not notice it.



- I do not understand the transition between the warm and cold colours and the point of it.
- I was really disoriented. I looked at one side of the video and tried to understand, but it was difficult to know if I should look at the section with the warm colours or cold. I just turned around in the video and did not know where to look.
- The focus was not on this effect I was trying to concentrate on the rest of the video.
- I wanted to look at the cold colour part.
- I barely noticed it.
- I did not understand where the important side was.
- The colour change was not how I usually perceive it. It was distracting and therefore not a place I would look at.
- The warm/cold effect was a bit confusing.

**Red circles:**

- I am not sure if I should look at the circles or not. My first instinct when I saw the red colour was that I should not look at it. The red colour draws my attention, but in the same way, it feels like I should not look at it. Both the blinking and colour makes me feel like that.
- I thought the red meant that it was something dangerous and that I should look at the other way instead. They were not understandable to me.
- It helped me to look at that direction.
- It was hard to find it, if I looked at another way, I would not be able to see it. I looked at the wrong way when I saw the red colour and that I should look at the other way.
- The circles blinked and made me thought that I was not supposed to look there. I was looking at the other way sometimes when it appeared. I figured out that I was supposed to look at that specific direction where the red circles appeared by the end of the video. An improvement could be a red circle as a frame instead of red in the entire circle. If it were guiding lines pointing to the circles, it would be more understandable that I should look at the red circles.
- If the circles are in my field of view, it is very noticeable. When it blinks over something, it could be seen as disturbing. In the same way, it needs more blinks if the person did not notice it the first time.
- The negative part with this effect was the red colour. I thought it was the wrong way I looked. It feels a bit distracting with the effect.



- They are noticeable, and with them, you know where to focus your gaze. The circles felt overwhelming at the same time.
- The circles are large and take a lot of space. When they appear in front of multiple items I cannot understand which item was the most important one.
- With the blinking red it made me not want to look there. Blinking red feels like danger.
- The red circles draw my attention, but I'm not sure if I like the colour red.
- It feels that it is something important where the circles are, and It really draws the attention.

### 3.2.2 Combination of effects

Most of the users admitted that a combination of effects could be even more effectual. They all acknowledged that their preferred effects would work together as a combination and could also be more effective. The graphical element effects together with the light effects were the most preferred combinations.

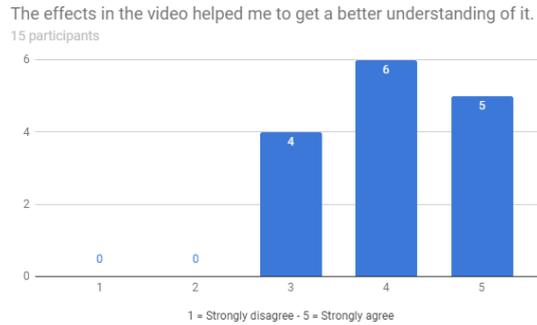
### 3.3 Section 1 of the user test

Most of the statements in the test were asked in part 1 of 2. The only statement asked in part 2 was to rate the effects individually. In part 1 of the user test, the users are viewing one video, and an interview is conducted after they watched it. The users saw their main video in this section. It is 3 videos in total, the first video that a user is viewing is called the main video. 5 people are watching one main video. 15 users in total. The participants were asked to rate a statement, comment on it was preferable but not mandatory.

**Statement 1: The effects in the video helped me to get a better understanding of it.**

#### Comments

- It was hard to keep up with the text. There was much else happening at the same time. I would rather look around instead of looking at the text.
- Yes, but if they didn't help me, I would look at another angle and miss some things and also miss how to do in the broadcast.
- I have no knowledge regarding broadcasting. In some cases, it was hard to get what someone is saying and therefore is text a good solution even for beginners.
- For someone that does not have the knowledge of this theme, it is helpful.
- The boxes that appeared with text helped to support the script and was helpful for me as a viewer to understand it better.

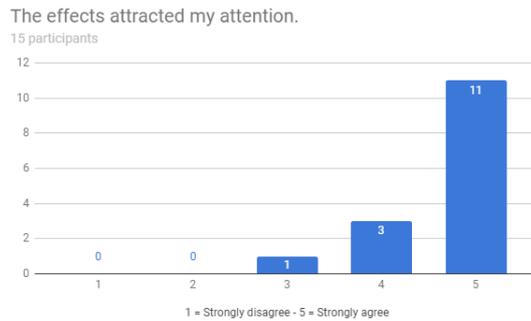


**Figure 15.** Diagram of statement 1.

**Statement 2: The effects attracted my attention.**

**Comments**

- Yes, but they were a bit hard to find.
- Mainly the guiding lines.



**Figure 16.** Diagram of statement 2.

**Statement 3: The effects distracted me from the rest of the content in the video.**

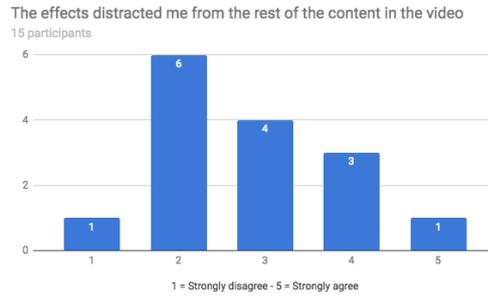
In this statement, the users answered if they felt like the effects took over too much from the rest of the content in the video. 1 in the scale represents strongly disagreed and implies that the effects did not distract at all and a 5 is the opposite, it strongly agrees that the users felt very distracted.

**Comments**

- Hard to hear the actors in some cases.
- If you have basic knowledge, the can effects be a bit distracting, but for a beginner like me, it is not distracting at all.
- When you are focusing on some effects that are appearing, you get easily distracted from the rest of the content.



- I still need to read the text, and that can be a little bit distracting.



**Figure 17.** Diagram of statement 3.

### 3.4 Expert analysis

The expert has experience from the research field concerning 360-degree videos and has also produced some videos for different companies.

A test was conducted similarly as the test with the users. The test was directed over Skype. The expert had the graphical element as the main video. Figure 18 shows the experts rating on a Likert scale, and the highest rated effect is presented from top to bottom.

Video effect	Category/video	Scale 1-5
Text in a box	Graphical element	5
Call out titles	Graphical element	5
Guiding line	Graphical element	5
Spotlight	Light	5
Dark/light	Light	4
Warm/cold colours	Colour	3
Red circles	Colour	3

**Figure 18.** The expert ratings given on the effects.

The comments below are the expert's thoughts regarding the scale.

**Text in a box:**

Too much text in the box but the effect attracted attention.

**Call out titles:**

The design of the graphical elements and the animation of it looks appealing. The information is short, and because of that it is not much time spent to look at them, but the information is still useful.



## **Guiding line:**

One thing that can improve the guiding lines is to reshape it. It does not need to be an arrow but to shape it in the form the viewers can see a clear pointing direction. It is still understandable which way the line was heading because of the movement, but it could be even more apparent.

## **Dark/light:**

The effect helped to get the direction to the lighter side. The dark/light effect guides to the important part without the viewers' awareness. When the light goes off, it becomes a natural way to look after it. The dark side is not entirely dark, and it still gives an opportunity to look at that direction.

## **Spotlight:**

The effect helps to look at the important side. To be guided this much to a particular side of the video was not comfortable. The viewers cannot make their own decisions with this type of effect. It becomes more restricted if this takes away the freedom of exploring, which it does. The effect guided way too much, but it certainly draws attention to the important side.

## **Warm/cold colours:**

The direction could be on the opposite side of the video were the cold colours are. It is a bit confusing where the attention should be. The warm and cold colours look too similar.

## **Red circles:**

The red circles guided to the important side. It is hard to see the whole image with a big red circle in front of it. The red circles are helpful to look at a specific direction, but it became annoying to look at them. A circle with just a red frame could be more useful to highlight something.

## **What is your opinion on the effects?**

It is a fun way to guide the audience with the help of moving lines. The lines were visible when they appeared, and it was apparent that one should follow them. When the lines led to the call out titles, a quick read of them was done to have it completed. When the lines guided to the box with text and the expert got to see them the first time it felt like it was too much text to read. Because of that, the direction was changed to another section of the video to see if it was something more interesting. The long text was not appealing but the box with text did attract attention.

**Statement 1: The effects in the video helped me to get a better understanding of it. (1=Strongly disagree, 5=Strongly agree)**



3. No more no less.

**Statement 2: The effects attracted my attention. (1=Strongly disagree, 5=Strongly agree)**

4. The effects drew attention. Some sorts of reward would be appreciated when viewers are looking in the right direction. It was nothing in the video that was surprising.

**Statement 3: The effects distracted me from the rest of the content in the video. (1=Strongly disagree, 5=Strongly agree)**

1.

### 3.5 Results

The individual effects impact on the viewers and all the effects impact combined in the video has been researched both with a Likert scale and open questions. The graphical element video gave the most positive feedback and was the most preferred one of the three videos, from both the users and the expert. All the effects in this video got over 10 votes of 15 on 4 and 5 ratings in the scale of 5 from the users. The expert gave a 5 to all graphical elements. The key to the high ratings is the effective combination of the three effects. The users and expert felt that video effects worked well together and the text in a box and call out titles had been hard to have without the guiding line.

The spotlight in the light video was the most preferred individual effect among all the video effects presented in the user tests. The spotlight got a 5 from 10 users and a 4 from 3 users, the expert, gave the spotlight a 5. It is a possibility to miss the spotlight, but the darkness around it makes it difficult to avoid. When the users see the spotlight, it is obvious what the important object is. The area is highlighted with a light around it, and the rest is dark around. The spotlight works really similar to a spotlight in a theater (Dwight, 2016). Both in the theater and in the light video is the dark not entirely dark, and it is possible to see something through it. The spotlight gives an effective guiding and points directly where the audience should look at. The difference between the guiding spotlight in theaters and the light video is that the theaters guiding is much more natural for the audience. Some users including the expert felt that they were too much guided with the spotlight in the light video. That is not usually what someone says when they have seen a show in a theater. The theater has been around for ages, and the spotlight has been there with it. 360-degree videos are relatively new, and that can be a reason. People are used to a spotlight in a theater, but they are not used to it in a 360-degree video. Another reason for the effectiveness is that people often sought-after light when darkness occurs. It is a big contrast between light and darkness. This concept also applies to the dark/light effect.



The ratings on the dark/light effect are spread out like the red circle effect. The difference between those two is that the dark/light effect has more consistent ratings and they are leaning towards the better. With 7 votes on 5 and 3 votes on 4. The dark/light effect is not as direct as the spotlight and can, therefore, be seen as confusing for some users. The effects work in the same way as the spotlight effect. The difference is that the dark/light is showing a larger area of light. The contrast between the light and dark is making it helpful compared to the warm/cold colours. Users who had the colour video as their first video could be confused when they saw the dark/light video later on. The reason for the confuses is that the warm/cold colour video has the warm colours on the important side. The section with the cold colours is not as important. It is the opposite in the dark/light video, the light is the most important side and the dark not as relevant.

The guiding line was the individual effect with most 5 ratings from 11 users and also a 5 from the expert. It was the second most effective single effect in total after the spotlight. The users thought it was advantageous to be guided towards an essential side in the video. They also believed that it was especially useful in this type of tutorial videos to know exactly where they should look. The users also stated that it could work on other 360-degree videos where something important needs to be shown. Moving objects can capture the attention of a viewer according to Howard and Holcombe (2010). That can be one reason why the guiding line was so helpful and effective. Another reason is the curiosity from the users. They felt a curiosity to follow the line to see where it would go. The main reason users voted 2 and 3 on the Likert scale is because they did not notice it. One solution is to scale up the lines and make them pointy like an arrow. Another solution could be to create multiple lines which appear from all possible directions and goes all the way to an important object.

Text in a box and call out titles got highly rated. Text in a box got 10 votes on 5, and 3 votes on a 4. Call out titles got 7 votes on 5 and 5 votes on a 4. The expert gave them a 5 each. The text in a box and call out titles are there to inform the viewers, besides to attracting attention. The text in a box got more votes on 5 mostly because it takes place and is more visible than a single call out title. Both their animations attracted the attention of the users. Both of the effects are depended on the guiding lines. They are just visible in one limited area of the scene and are not going to be spotted if the viewers are not looking there. Therefore, is the combination of the guiding lines effective because they guide the viewers towards the text in a box and the call out titles. The text in a box and call out titles makes the viewers stay in that direction. When they are appearing, they know that something more is going to occur.

The colour video was the least preferred video, and the two effects warm/cold colour and the red circle was mostly a negative experience for the users. This was both the users and the experts' opinion. The warm/cold effect got 6 votes on 1 and 6 on 2, the last 3 voted on a 3 rating. The expert gave it a 3 as well. This was the only effect not to get either 4 or 5 ratings. The video had a cold colour grading from the beginning of the video, and when something of importance happened, a warm colour appeared in the area around it. The users including the expert did not



understand it and felt mostly confused. The way to draw attention to an essential area is a change in colour Malamed (2015). That is one of the reasons this effect is included in the work, another reason is the contrast of both colours (Yan and El-Nasr, 2006). The expert pointed out the similarity between the cold and warm colours, and that could be a reason why it was confusing. Other reasons for the warm/cold colour effect appearance in this work is described in the method part.

Some users felt that the red colour attracted their attention, but that they should not look at that section. The colour red was mostly negative and was associated with something dangerous. Other users felt that the red circles took too much space and covered the important angles including objects and subjects, so they could not see it. The red circles gave mixed feelings and therefore is it the effect of most spread out ratings. 4 users gave it a 1, 2 users gave it a 2, 1 user 3, 1 user 4 and 7 users gave it a 5. The expert gave it a 3. The colour red is considered to be one of the most noticeable ones according to Samara (2014). That was one reason it was picked to the video, and with 7 votes on 5, it shows that it is noticeable. Some users including the expert thought that just a red frame and not a filled circle would be more helpful. It would undoubtedly highlight objects but how effective would it be and in which way should it attract attention are questions for the future.

The effects in the light and colour video were not distractive as the video with graphical elements. The user felt that it was a lot of video effects happening at the same time and it was hard to keep up with it and at the same time to focus on the rest of the content. The expert did not feel distracted at all. The main distraction in the graphical element video is the text in a box. If the users choose to read it, they will only concentrate on that. It is also a question of how fast somebody is reading. If the audience reads fast, they will not miss much of the action, but if it takes a longer time to read it, they can miss some action. Call out titles works better in the scenario where some individual words are appearing instead of a long text. In the colour video is the red circles the main distraction. The warm/cold colours can give some distraction as well if a viewer is confused about the purpose. It made users confused, and they could lose focus on the rest of the content.

Combination of effects could be an improvement in a video to attract attention to an area. The graphical element video and the light video was the two most rated videos, and the effects of both videos could work well as a combination. The guiding line would work as the most important effect and have a significant role. It could be used to guide the viewers towards the light in the dark/light effect and towards the spotlight. When the viewers have turned their position towards the spotlight or to the light, some sort of text and call out tiles could appear.

Most of the users would like to see some information about the effects at the beginning of the video. They did not understand what the effects were doing at the start. This information would need to be researched in the future to see if it can give the viewers some impact when they are watching a 360-degree video.



### 3.6 Screen recording

Screenshots from the screen recording can be seen in Appendix A. The images are from all 15 tests that the participants attended. The last set of images show screenshots from the user test which the expert did. The screenshots also show which order the participants and the expert watched them. They are showing where the attendances were watching at a certain time in the video when the effects appeared. If the effects are not visible in the pictures, it means that the participants looked elsewhere.



## 4 Discussion

The first section 4.1 discusses some topics that were brought to light during the work. The expert discussion at 4.2 goes deeper into the results and other issues regarding this paper and compares it to the field.

### 4.1 General discussion

The results of the light video are interesting. The prediction of what the user was going to say about the light video was mostly negative comments. Most because of the dark and light effect but mainly because of the spotlight effect. This kind of effect can make the user feel that they are required to look there. This could create a feeling of less freedom to explore the scene in a 360-degree video. The freedom of exploring is associated with a 360-degree video. The results were on the contrary to the prediction, especially the spotlight effect, this effect was showing the users where the important part was for the moment. The users felt that it was positive to know where they should look. Some users said that it was fitting with the tutorial. The question with that comes, could this effect be positive in other types of 360-degree videos? This question could be answered in the future. The expert did feel that the spotlight is effective in attracting attention. The negative part was that it guided too much. This opinion about the effect can be related to the experience and knowledge in the field.

After all the user tests and the expert test, an interesting theory can be concluded. The effects are formed and animated in different ways. They can, therefore, draw attention to various aspects. The guiding line for example and the spotlight gives an exact pointing on where the viewers should look. The dark/light and the warm/cold colour works almost the same way were they instead show a more extensive section. In this case was the dark/light much more useful than the warm/cold colours. The text in a box, call out titles, and the red circles are made to attract attention and make the users stay in that direction. In this study were the red circles not so successful. Furthermore, the theory works step by step, and an example with the most helpful effects would work like this: the dark/light show an extensive area where the viewers should look for the moment, the guiding line and the spotlights role is to show precisely where in the area they should look at. The text in a box and the call out titles are there to let the viewers stay there for a bit longer.

The idea from the beginning was to see how the users would react to the effects without any information about it. All the video effects besides the colour effects were obvious to the users without any given information. With that said it took a while for them to get what the effects were supposed to do. Information at the beginning of the video with text or speech indicating that they should follow some certain effects in the video is yet to be explored.

The videos are divided into different effect types. One video is with graphical elements, one with lights and one with varying effects of colour methods. The light and colour effects can be seen as graphical elements like the red circles and the spotlight for example. They are classified as colour and light for the red colour and the light in the spotlight, not because of their shape. Dividing the video effects into



three videos instead of having one video with too many effects was preferred for the most valid results.

Post-production methods in combination with techniques in the set of a 360-degree video are going to give the most valid results in the field of attracting attention. Post-production methods used in 360-degree videos without techniques from a video set can be useful in some cases. For example, in a popular 360-degree video where it is supposed to explore animal life. The viewers are experiencing it from a perspective that traditional videos do not have. The problem with this type of videos is to make the scene unique to attract attention. To have actors is hard in this type of video. If there are lions, it can be extremely dangerous. The point of it is to get an experience of the animals. In this example is the post-production the central part and the main techniques to draw attention to something. In this type of videos, is the freedom of exploring even more important. The guiding lines from this research would fit into this type of videos where the action happens now and then, not all the time. The guiding line is described as smooth and not taking too much space. If something appears in the scene, the guiding lines can help to attract attention towards the action.

The attention mechanism is complex and is hard to control it with only the post-production part as help. Sudden and unpredictable events can occur without a person being able to influence the outcome of it. Therefore, would both the filming part in the set and the post-production part of it sort out much of the randomness. Still, it is hard to sort out every random event. Sudden moves in motion and sudden sound or noise can redirect the focus from an important part.

The software used in this paper was Adobe Premiere Pro. This software has come a long way when it comes to implementing features like tools and video effects for 360-degree videos and VR<sup>9</sup>. It can be improved even more, especially in the presets for video effects. The effects used in this paper for the videos were mostly regular ones which are not entirely suited for the 360-degree material. Concepts and effects used in the videos in this study can be adapted for editing software like Premiere Pro to make a new set of preset effects, suited for 360-degree videos.

## 4.2 Expert discussion

The expert followed the general guidance in the beginning of a video but did not feel to do it more than that. The idea of how the location is looking like was quickly established. The expert did not move more than 180-degrees in the video after a while.

The two keys to guiding are in general graphics and sound. Sound gives the best guiding. The sound helps to look at a person that talks and can, therefore, make the audience follow the action from the information provided. The presence of the graphics did also help with the guiding. The 360-videos in this work feels a bit like VR or science fiction. Mainly because of how the shape in the graphical elements was presented, but also the help of colour contrast and the colour in general, and this

---

<sup>9</sup> <https://www.roadtovr.com/adobe-premiere-pro-now-includes-vr-editing-interface-project-clovervr/>



combination is the right way to go. One improvement could be if the videos contained more graphical elements and if the dark/light effect transformed to a spotlight effect. If text appeared in the same time, it could be a very effective way to guide the audience. The significant amount of guiding in the spotlight effect would not be as annoying then. The light effects could also be a part of the video but only if it runs as a complement to the video with the graphical elements as the main effects. In fact, all the other methods and effects of guiding would work as a supplement. The sound and the graphics are the engines which should guide the audience most of the time.

The expert does not like to see long texts in 360-degree videos. The positive outcome from the text in the graphical elements video is that the size is enough for the viewers to see it. Call out titles or other graphical elements with only one word which describes something is more appealing and useful than longer texts. The titles and words are good for the context in the video.

The length of the video is another topic of importance to discuss. The videos in this work are too long in general. In the experts' field of work and studies that have been conducted, is showing that the interest from the viewers is dipping after 2 minutes. The videos are facing two scenarios, either the viewers are turning the video off completely, or they'll stop to be active after 2 minutes. The expert did feel the same way with these videos where the activity became less after approximately 2 minutes. The effort is not the same further in the video. The desktop is one reason that can become an obstacle to watch on. Miss-click can be made in the video, and the video can be exited from full screen and even turned off easily. With a smartphone, for example, these problems occur less and can be more useful to interact on.



## 5 Conclusion

This section presents the two main research questions in the thesis. The questions 1 and 1.1 is answered by the related work. Future work is also a part of the conclusion.

### 5.1 Research Questions

**Question 2:** How could light, graphical elements and colour be used to attract viewers' attention in a 360-degree video?

The 360-degree video is still considered as a new medium, but it has been around for some years now. More research is required to get full knowledge of it. One thing that can be improved is the way the creators draw attention to a section in a 360-degree video. Attracting viewers' attention towards a specific side in the video can be handled by different methods used in both the filming part of the production as well as the post-production part of it. Relatable methods can be used in the set like gestures and guiding with voice or another type of sound. In post-production can effects be used to guide the viewers. For this work, the post-production has been researched. Video effects could be used in different ways and be divided into different groups. Graphical elements, lights and colour effects are some groups that can be used. Graphical elements can contain guiding lines, text in a box and call out titles to attract attention. In the light part can dark and light areas be used as video effects to draw attention towards something important. A spotlight is also something that points towards a direction and is considered as a light effect. Colour is another type of effect group. Different colours can be used to direct viewers' attention to something significant. Red circles can be an effect applied to attract the attention towards it. Colour effects are more challenging to manage and drawing attention to a specific area is something that needs more research. Something that was not included in this work was sound effects, and that could also be considered as a type of effect group. Both the size of the objects and the animation of the effects are attracting viewers' attention.

**Question 2.1:** Which element is the most suitable?

The video with graphical elements is more suitable than the video with light effects and the video with colour effects. The spotlight is the most suitable effect and gives the viewers an obvious pointing direction where they should look at. It is not the best effect when it comes to providing the viewers some freedom to explore the scene. Guiding line is the second most suitable effect. This effect is not forcing the viewer to look in a direction as the spotlight. The graphical elements text in a box and call out titles are complementing the guiding lines, and they have a function, the effects also provide more context to the story. Dark/light effect can be effective to see an important area that is more extensive. The concept is similar to the spotlight and can also give a feeling that it is too much guiding. Warm and cold colours are the least suitable effects and require more research to see if it is possible to do them differently. A red circle is attracting the attention but takes too much space. 7 users of 15 felt that it was not helpful to look at the red circles. A combination of effects would give the viewers a more effective video. The guiding lines could work with



the spotlight and the dark/light together with other graphical elements like call out titles and text in a box. In a 360-degree video with a spotlight and dark/light effects can the viewer still miss the lighter side if they look in another direction and do not move. The guiding line effect can in that scenario be good to have as a combination to point towards the light side.

## 5.2 Future work

The field of 360-degree videos has many topics to be explored. To attract attention in the most effectual way it needs more than some effects from post-production. A combination of what can be done in the set of a 360-degree video filming together with the post-production part needs to be researched. The research needs to be done from both parts of the video production to be able to combine the two different techniques at the end. The effects of this work need still to be researched more on. Especially the combination of different effects to attract the attention of the audience even more.

The theme of this work is a learning video, a tutorial on the setup of a broadcast. The effects could be tested in other types of 360-degree videos to see if some of the effects would fit there. The users watched the first video without the knowledge of the effects. Information at the beginning of the video with text or speech that they should follow some specific effects in the video can yet be explored. Users freedom of exploring would be questioned in that case.

Different kinds of sound effects are frequently used in video games and traditional videos for example to attract attention. Sound effects and audio devices used in a 360-degree video is something that needs to be researched separately before using it in a context of attracting attention. Sound techniques in a production set can be used and combined with effects from the post-production part to draw attention. This outcome would be interesting to follow up on.



## References

Argyriou, L., Economou, D., Bouki, V., & Doumanis, I. 2016. Engaging immersive video consumers: Challenges regarding 360-degree gamified video applications. *2016 15th International Conference on Ubiquitous Computing and Communications and 2016 International Symposium on Cyberspace and Security (IUCC-CSS)*, Granada, 2016, pp. 145-152.

Brillhart, Jessica. 2016. In the Blink of a Mind—Attention. Medium. <https://medium.com/the-language-of-vr/in-the-blink-of-a-mind-attention-1fdff60fa045> [2018-04-27].

Brown, A., Sheikh, A., Evans, M., & Watson, Z. 2016. Directing attention in 360-degree video. *IBC 2016 Conference, 29 (9.)-29 (9.)*.

Brown, A., Turner, J., Patterson, J., Schmitz, A., Armstrong, M., & Glancy, M. 2017. Subtitles in 360-degree Video. *Adjunct Publication of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video - TVX '17 Adjunct*, 3–8.

Clinks. n.d. *Using comparison group approaches to understand impact*. [online]. Available at: <https://www.clinks.org/sites/default/files/UsingControlGroupApproachesToIdentifyImpact.pdf> [Accessed 24 July 2018].

Creator Blog. 2017. *Hot and Cold: Heatmaps in VR*. YouTube. <https://youtube-creators.googleblog.com/2017/06/hot-and-cold-heatmaps-in-vr.html> [2018-04-27]

Dooley, K. 2017. Storytelling with virtual reality in 360-degrees: a new screen grammar. *Studies in Australasian Cinema, 11(3)*, 161–171.

Dwight, Logan. 2016. *These VR Film Tips Show How To Direct Audience Attention*. UploadVR. <https://uploadvr.com/vr-film-tips-guiding-attention/> [2018-04-26].



Franconeri, S. L., Hollingworth, A., & Simons, D. J. 2005. Do new objects capture attention? *Psychological Science*, 16(4), 275–281.

Howard, C. & Holcombe, J. 2010. Unexpected changes in direction of motion attract attention. *Attention, Perception, & Psychophysics*, 72(8), pp.2087–2095.

Li, F., Bai, H., & Zhao, Y. 2017. Visual attention guided eye movements for 360 degree images. *2017 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC)*, (December), 506–511.

Malamed, C. 2015. *Visual Design Solutions: Principles and Creative Inspiration for Learning Professionals*, John Wiley & Sons, Incorporated, Somerset. Available from: ProQuest Ebook Central. [2018-04-20].

Maugey, T., Le Meur, O., & Liu, Z. 2017. Saliency-based navigation in omnidirectional image. *2017 IEEE 19th International Workshop on Multimedia Signal Processing, MMSP 2017, 2017–January*, 1–6.

Murias, K., Kwok, K., Castillejo, A. G., Liu, I., & Iaria, G. 2016. The effects of video game use on performance in a virtual navigation task. *Computers in Human Behavior*, 58, 398–406.

Neng, L. and Chambel, T. 2010. Get around 360° hypervideo. *Proceedings of the 14th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek '10*.

Owens, Jim & Millerson, Gerald. 2012. *Video production handbook*. 5th ed. Amsterdam: Focal.

Ran, L., Zhang, Y., Zhang, Q., & Yang, T. 2017. Convolutional neural network-based robot navigation using uncalibrated spherical images. *Sensors (Switzerland)*, 17(6), 1–18.

Robson, Colin & McCartan, Kieran. 2016. *Real world research: a resource for users of social research methods in applied settings*. Fourth Edition Hoboken: Wiley.



Rubin, J., & Chisnell, D. 2008. *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*, John Wiley & Sons, Incorporated, Hoboken. Available from: ProQuest Ebook Central. [2018-04-26].

Samara, T. 2014. *Design Elements: Understanding the Rules and Knowing When to Break Them - Updated and Expanded*, Rockport Publishers, Osceola. Available from: ProQuest Ebook Central. [2018-04-26].

Scaramuzza, D. 2012. Omnidirectional Camera. *Encyclopedia of Computer Vision*, 14.

Tang, A., & Fakourfar, O. 2017. Watching 360° Videos Together. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, 4501–4506.

Yan, S., & El-Nasr, M. S. 2006. Visual attention in 3D video games. *Proceedings of the 2006 Symposium on Eye Tracking Research & Applications - ETRA '06*, 42.

Zhang, L., & Lin, W. 2013. *Selective Visual Attention: Computational Models and Applications*, John Wiley & Sons, Incorporated, New York. Available from: ProQuest Ebook Central. [2018-04-20].

Zhengqing Li, Shio Miyafuji, Toshiki Sato, Hideki Koike, Naomi Yamashita, and Hideaki Kuzuoka. 2018. How Display Shapes Affect 360-Degree Panoramic Video Communication. *In Proceedings of the 2018 Designing Interactive Systems Conference (DIS '18)*. ACM, New York, NY, USA, 845-856.

Zhu, Y., Zhai, G., & Min, X. 2018. The prediction of head and eye movement for 360 degree images. *Signal Processing: Image Communication*, (September 2017).



## Appendices

### Appendix A Screenshots from the screen recording

This test is conducted by user:

1





2





3





4



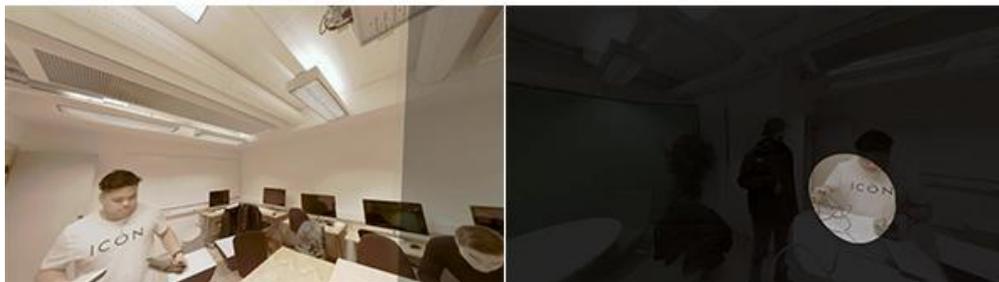


5





6





7





8





9





10





11





12





13





14





15





The Expert





## Appendix B Material from the planning phase before the filming

**Script:**

A: Comes in from the door.

T: Stands besides AT.

K: Stands beside the lockers.

K: Takes the tripod from the lockers.

A: Sits down at the table.

T: Goes to the locker and takes the capture card and the HDMI cable.

K: Sets up the tripod.

T: Sets up the capture card.

\*A: T, what does this box do?

\*T: The capture card converts the image from the camera to the computer.

\*A: *Replies.*

K: Takes the camera from the lockers.

T: Takes the mixer and the microphones.

\*T: Yo A! Do you know what this does?

\*A: No, explain!

\*T: This mixer helps us to control the audio from the microphones like volume for example. You need a XLR cable between the mixer and the microphone.

\*A: *Replies.*

K: Sets up the camera on the tripod.

T: Sets up the mixer and the microphone. Sets up the USB-microphone directly in to the computer.

K: Puts the HDMI cable in the camera.

\*K: A, this is the HDMI cable and gives you both video and sound from the camera.

\*A: That's obvious K, I already know that.

K: Starts the camera and sees if correct settings are set.

\*K: Do we have feed from the camera?

\*AT: Yes, we have feed from the camera. We can now start the live show.

T: Checks with A together with AT if the microphone sounds good.

\*=Conversation

