It’s All Around You: Exploring 360° Video Viewing Experiences on Mobile Devices

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ABSTRACT

360° videos are a new kind of medium that gives the viewers a sense of real immersion as they glimpse the action from all angles and directions. Naturally, professional and amateur film-makers are actively adopting this new medium for transformative storytelling. Despite this phenomenal progress in 360° video creation, current understanding on users’ viewing experience of these videos is limited. In this paper, we present the first comparative study on the user experience with 360° videos on mobile devices using different interaction techniques. We observed 18 participants’ interaction with six 360° videos with different viewport characteristics (static or moving) on a smartphone, a tablet and a head mounted display (HMD) respectively and measured how they interact with the content. We then conducted semi-structured interviews with the participants in which they explained their interaction with and viewing experience of 360° videos across three devices. Our findings show that 360° videos with moving viewports elicit higher engagement from the viewers, and offer superior viewing experience. However, these videos are cognitively demanding and require constant user attention. Our participants preferred the condition with dynamic peephole interaction on a smartphone for watching 360° videos due to the simplicity in exploration and familiarity with navigation controls. Many participants reported that the HMD offers the most immersive experience however it comes at the expense of higher cognitive burden, motion sickness and physical discomfort.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**; **User studies**; *Interaction techniques*;

KEYWORDS

360° video; Head Mounted Displays (HMDs); Mobile Devices; Video Consumption; User Experience

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1 INTRODUCTION & MOTIVATION

360° video is a rapidly growing new kind of medium that allows viewers to sense the action from all angles and directions. These videos offer viewers a unique experience as they feel as if they are actually in the action, as it unfolds before their eyes.

Naturally, film-makers are actively adopting 360° videos to transform storytelling and make viewers engaged with the content more emotionally. Such captivating storytelling is naturally appealing for the professional film industry. However, due to the availability and advancement of low-cost camera equipment, 360° videos are now becoming a mainstream medium for engrossing and immersive journalism [1], brand advertisement [11], and live sports [12]. Recognising the potential, on-line platforms such as YouTube, Facebook, Vimeo among others are now actively supporting 360° video formats. Furthermore, YouTube has set up an on-line studio that offers various resources so that anyone can produce their omni directional films. While the creation process of a 360° video has improved greatly in recent years, this technology has yet to find the *appropriate, ergonomically usable and emotionally engaging* delivery mechanism that resonates with a mass audience.

It is natural to expect that a 360° video is most immersive when experienced through a virtual reality device, e.g., a head-mounted display (HMD). However, there has not been many systematic exploration to assess whether HMDs would offer rich experiences with 360° videos and paves the way for a wider adoption. Recently, multiple mobile platforms have enabled support for 360° videos. For example, the YouTube application on both iOS and Android now supports watching and exploring 360° videos though a dynamic peep-hole exploration technique [22] or touch-based navigation. Despite this progress, very few studies have reported a reflection on user experience with these devices while watching 360° videos or more generally the delivery modality that evokes emotional engagement with 360° content - whether a personal story or artistic endeavours.

In this work, we examine two specific aspects of this larger puzzle, namely *i) How different viewport characteristics of a 360° video influence viewers’ behaviour, and ii) which device viewers prefer to watch a 360° video?* Viewport composition can be static or moving. In the former static viewport (SVP) case the cameras are statically placed in the centre of the scene while shooting a 360° video, where as in the later moving viewport (MVP) case, the cameras move while recording the video. We hypothesise that this composition dynamics will have a profound influence on how a viewer will explore and experience 360° video scenes and the overall video. Exploration indicates the degree of user activity of looking around in the 360° video to discover more content. To this end, we quantitatively logged 18 users' exploration patterns on a smartphone, a tablet and an HMD respectively while watching six 360° videos produced with both static viewport (SVP) or moving viewport (MVP)[1] We then interviewed the participants to understand their subjective experience with these videos on different devices taking into account *exploration, navigation, and immersion* factors.

Our results show that although MVP videos are cognitively demanding, they offer richer and engaging viewing experience than SVP videos. Dynamic peep-hole interaction offered in modern smartphones is preferred over HMDs due to the familiarity and simplicity in content exploration. Concerning immersion, HMDs offer the best user experience; however, this immersive experience comes at the expense of demanding cognitive resources and physical discomfort.

2 RELATED WORK

A number of past studies have reported user experience with mobile video consumption exploring impact of content, environment, device interaction, and modalities. Our work draws on these past research and focus primarily on assessing 360° videos viewing experiences. In the following, we position our work with respect to these areas of related research.

In one of the earliest studies on mobile video consumption practices, O'Hara et al [24] reported the different ways mobile videos are integrated into people's everyday lives. This rich ethnographic study identified motivations and values that drive mobile video consumption and elicit engaging social interactions in different socio-dynamic contexts. As omni-directional content started appearing, Benko et al. [2] explored multi-point interactions with immersive omni directional visualisations in a dome. Bleumers [3] and also Zoric et al. [37] took this research into the living room and further studied the consumption of 360° videos on *static* TVs. Similar to the work of Zoric et al [37], Pece [26] identified challenges that come with this new interactive content, e.g., balancing active and passive viewing, enabling orientation in the panoramic image space and supporting both individual exploration and social conversations around it. These studies uncovered a set of concrete usability challenges that arise while consuming omnidirectional content in different mobility settings.

A number of recent research explored interaction experiences with panoramic videos. Kasahara et al. [18] studied the viewing experience of first person omnidirectional video. Huber et al. [16] further explored different user interfaces for *mobile* video browsing and later explored effective interaction with 360° videos using HMDs [27], and Jumisko-Pyykkö et al. [17] researched the user experience when watching a mobile 3D video in a car. These work highlighted the challenges that device form and interaction affordance put on users' viewing experience of omnidirectional videos. Our work is shaped by these findings, as we extrapolate on their suggestions. However, we investigate the viewport dynamics and device preferences instead of interaction dynamics.

Concerning content and immersion, Fonseca et al. recently reported a study that shows HMD offers superior immersion and can trigger a higher emotional response from captivating content than other handhelds [10]. In a similar endeavour, Ramalho et al. described the effect of multi-sensory immersion on engaging and emotional user experience with 360° videos [30]. These work primarily investigated the emotional dynamics in content consummations. In contrast, our work looked at viewport composition dynamics and device preferences independent of the content and its emotional appeal.

Besides research on content consumption experience when watching videos, there is a large body of research on interaction techniques and modalities. Peephole interaction [29] with mobile devices was heavily studied e.g., by Rohs et al. [31, 32] and recently repeated in different contexts [8]. Many research also looked at controllers [6, 20] or device types [13, 25, 34] on immersion in games and other VR worlds. Already in 1999 Pierce et al. [28] published guidelines for successful HMD-based experiences. Current HMD manufacturers are pushing hard to close the gap between simulation and reality as demonstrated by previous research [21], e.g., by introducing new hardware (e.g., the Oculus Rift consumer version) or algorithms (e.g., Mayo Clinic's Galvanic Vestibular Stimulation technology[2]). While this body of research is very relevant to the work presented here, we intend to understand device dynamics with respect to 360° videos. Perhaps, the closest research to ours was reported by Boonsuk and his colleagues, where they evaluated the optimal interface for panoramic 360° videos [4]. Their primary focus was on uncovering the degree of spatial cognition that a 360° video demands. In contrast we look at the mobile user experience with 360° videos.

3 USER STUDY

We conducted a user study to investigate the viewport as well as the device dynamics of 360° videos in more detail. We explored the interaction with and viewing experience of two different type of 360° videos on three different devices with different interaction modalities.

3.0.1 Participants. We recruited a group of 18 people from our research facilities (9 males, 9 females, age range 20 – 54). For recruiting, we used stratified sampling with snowball sampling within each stratum. One participant could not complete the experiment due to cyber-sickness while wearing the HMD. So we recruited another participant of the same gender for completeness. All participants owned a mobile device (a smartphone or a tablet or both), but none of them had experiences with actively watching 360° videos.

3.0.2 Apparatus. We used a 5.1 inch Samsung Galaxy S6 as the smartphone on which the 360° videos were navigated using a dynamic peephole navigation [22], a 10.1 inch Samsung Galaxy Tab 2 as the tablet on which the 360° videos were navigated using touch as an input modality, and Samsung Gear VR as the HMD on which the content can be explored using full body input [35].

All study participants watched two 360° videos one with a static viewport (SVP) and one with a moving viewport (MVP) on each of the three different mobile devices. This resulted in six 360° videos for each participant. In the smartphone and HMD conditions we

[1].

[2]http://www.vmocion.com

Type	Name	Narration
SVP	`Waldo`[9]	Guided exploration of a scene to look out for a person named *Waldo* [3:53 min].
SVP	`Refugee`[33]	Short documentary about the refugee crisis in Europe [3:16 min].
SVP	`Horror`[19]	Japanese horror movie [3.02 min].
MVP	`Dive`[7]	Dive with sharks near the sunken wreckage of the *Ray of Hope* [4:10 min].
MVP	`Mountain`[14]	Last steps to the *Mont Blanc* summit [3:17 min].
MVP	`Car`[23]	Convertible drive on the *Pacific Coast Highway* [2.16 min].

Table 1: List of static viewport 360° videos (SVP) and moving viewport 360° videos (MVP) used in the user study.

logged the 2D orientation data from the built-in gyroscope of Samsung Galaxy S6, and on the tablet, we logged the touch (and scroll) input on the screen using a custom logger application. We use the orientation data to study the degree of 2D exploration in the smartphone and HMD condition. For the tablet, we analysed the scroll movements with respect to the screen resolution to acquire participant's degree of exploration on the 2D plane.

3.0.3 Video Selection & Characteristics. The six 360° videos (professional as well as semi-professional videos) used in the study were selected from the 360° videos YouTube channel[3]. All 360° videos were ranked within the top 50 trending 360° videos in this channel in March 2016.

First, we went through all videos and grouped them by their main viewport characteristics. Independent from the content shown in the videos about 40% of the 360° videos mainly used one or multiple static viewports (SVP) (i.e. the cameras were placed on a stand in the centre of the scene to record the 360° video), whereas the rest mainly used moving viewports (MVP) (i.e. the cameras were moved while recording the video). Most of the videos also combined scenes with SVP followed by scenes with MVP and vice versa. Therefore we first selected those 360° videos from the list that mainly used one VP throughout the whole video and were about 3–4 minutes long. Videos that were changing the viewport dynamics between SVP and MVP multiple times were removed as possible study video candidates. We excluded extreme MVP videos, which rapidly alter the VP in 3D dimensions (e.g., roller coaster rides or fighter jet flights) to avoid cyber sickness of our participants. Naturally, the content of MVP 360° videos is different to the content of SVP 360° videos; as such we carefully assessed the content of the videos and selected only those videos with comparable content but having different viewport characteristics. Table 1 lists all the videos and their links that we have used in the study after following the selection procedure mentioned above.

3.0.4 Design. Our experiment followed a 3x2 factorial within-subject design with the different devices (tablet, mobile, HMD) and the viewport characteristics (SVP, MVP) as the factors. The three videos for each viewport were randomly assigned to the conditions. The order of device condition was counterbalanced and presented in blocks. For example, both videos (SVP, MVP or vice versa) with the HMD happened in one block without allowing the user to switch to another method. With 18 subjects the test application on the devices recorded 108 trials.

[3]https://goo.gl/NLNr7H

3.0.5 Procedure. Initially, participants were given a written task description and were asked about their demographics and device experiences. Next, the participants tested each device condition while seated in a revolving chair in front of a table. We used a 360° video with an SVP in this training phase [36].

After each device condition, the participants were requested to complete a SUS questionnaire[4]. After completing all conditions, we conducted semi-structured interviews with the participants and had them rate the quality of the 360° videos as well as their preferred device. To stimulate discussion of possible reasons for selecting a particular type of device, we presented the participants with three possible factors: exploration, navigation, and immersion. Later, we analysed data by coding the selection reasons against each device.

Each interview was audio-recorded for later analysis. The total time each participant took was about 50 minutes.

4 RESULTS

In this section, we discuss the study results from two main perspectives. First, we discuss participants' viewing experience with 360° videos with different viewport characteristics. Then, we discuss which devices were preferred for watching 360° videos.

4.1 Understanding Viewport Dynamics

First, we assessed how different viewport compositions influence viewers experience independent from the content shown in the videos. In particular, we were interested in answering whether different viewports demand different exploration patterns. We noticed that MVP videos, no matter what content was shown, consistently require more exploration from viewers than SVP videos for all three devices. On average, all participant's exploration rate with MVP videos was 17.3° per 30 seconds, on the contrary for SVP it was 14.6° per 30 seconds. We run a paired samples t-test to evaluate the difference in the exploration rate on viewports across all participants and found significant difference in the exploration rate for SVP and MVP ($t(53) = -12.933$ and $p < .01$).

As an illustration of this observation, we randomly picked two participants' trace for two videos with varying viewports across three devices from our sample and plotted their exploration behaviour in Figure 1.

This observation is counterintuitive as the natural expectation is that when the viewport is static viewers will explore more to

[4] The System Usability Scale (SUS) is a technology agnostic survey that are used to assess the usability of a variety of products or services. It is composed of ten statements contributing to a single score ranging from 0 to 100 [5].

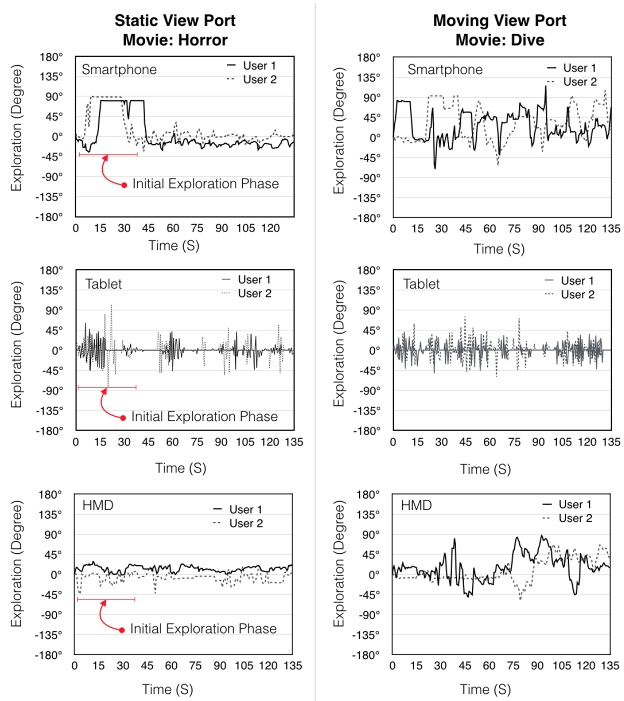

Figure 1: Two randomly selected participants' exploration behaviour with SVP and MVP videos in the mobile, tablet and HMD conditions. Here, exploration indicates the degree of user activity of looking around in the 360° video to discover more content. We notice that SVP videos typically have an initial exploration phase, in contrast MVP videos are explored throughout.

experience the action from all angles and directions. However, our results suggest the opposite, i.e.; viewers explore the viewports as they keep changing instead of focusing on the moving action frame.

Qualitative feedback from the participants shed some light on this phenomenon. A majority (14) of the participants mentioned that static viewport becomes monotonous after several seconds (5-10s) of initial exploration while moving viewport constantly encourages them to explore the action frames from different angles. In the interview one participant commented:

> *"SVP are boring. You look around, and then you are done...."* (P5)

Similar comments were received from other participants (P1, P8, P17).

Also, an additional promise of 360° videos is that the viewing experience is different for different individuals. Therefore, we looked at the exploration behaviour at individual scale. We refer to Figure 1 again here, in which a pair of randomly picked participants watching the same 360° video in the same device[5]. We observe that for all the cases, the same video was explored differently by different participants. For example, while watching the `Horror` video on mobile the two participants' exploration rate was 13° and 19° per 30 seconds respectively; for `Dive` on HMD these rates were 21°, and 31° per 30 seconds respectively. Similar results were observed for other pairs. Indeed, we found that across all participants, their degrees of exploration were not correlated (Pearson's $r = -0.28, 0.14, -0.12$ for mobile, tablet and HMD respectively, and $p > .01$ for the same movie).

Another interesting observation was that SVP videos elicit exploration in short bursts followed by a short period of no exploration. This is particularly the case at the beginning 10 to 30 seconds of the videos during which viewers initially explore the viewport (e.g., as in `Horror` or `Waldo`) before settling on to the centre action frame with occasional exploration.

Although MVP videos are more appealing for exploration, it comes at the expense of demanding user attention, which often causes confusion and even frustration among the viewers. This is because as the viewport changes, viewers want to experience the 360° video from all angles, and in the process sometimes they miss interesting actions, or they become confused. In particular, while watching a video on an HMD that offers a high degree of immersion, such viewport changes makes viewers confused. One specific comment was:

> *"You are navigating in the scene and all of a sudden the entire scene changes. That is confusing...."* (P1)

Another remark was:

> *" I looked left, then I looked right. When I looked left again , the scene was different ..."* (P17)

One interesting situation that we encountered multiple times in our study was that the sudden transition of viewports without adequate transition cues in a video caught participants by surprise while using a HMD (e.g., as in `Car in 0:31 min`). Due to the high immersion factor, if a scene transition happens unexpectedly it causes physical distress to viewers. As such the filmmakers need to provide effective and artistic cues either visual or auditory, to avoid such situations in a 360° video .

Videos are primarily about the filmmaker conveying a message, with artistic composition of action frames to construct the most compelling story. However, given the freedom of exploration that the viewers possess in 360° videos we concur that directed storytelling would be difficult without implicit or explicit guidance. This is especially essential for MVP videos as viewers frequently explore the viewports, and in the process, they might miss the most interesting frames in the video. Multiple remarks (11) from our participants emphasised this fact. One participant mentioned:

> *" In a regular video, the viewport is picked by a pro filmmaker. Now I might miss out on something...."* (P11)

Although these concerns with MVP based 360° videos, our participants rated MVP videos higher than SVP videos, as shown in Figure 2(a,b). `Diving` and `Car` received the highest ratings (both are MVP videos), followed by `Refugee`(SVP), `Mountain`(MVP), `Horror`(SVP) and `Waldo`(SVP). On an average 62% of the participants rated MVP videos as very good or good as opposed to 32% rating SVP videos as very good or good. A Chi-square test also confirmed that participants' rating towards 360° videos significantly

[5]For readability we present the first 135 seconds of each video.

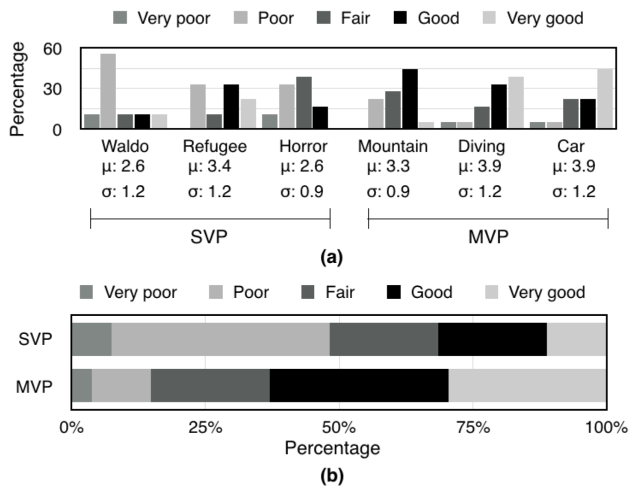

Figure 2: (a) Participants' subjective rating of different 360° videos and (b) comparison of SVP and MVP based videos

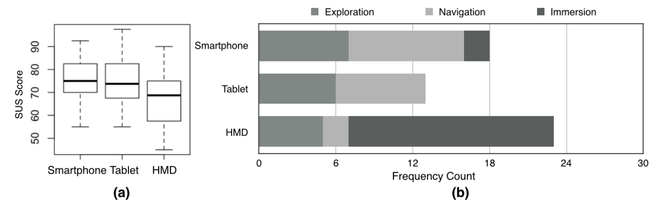

Figure 3: (a) SUS scores of mobile, tablet and HMD and (b) different factors influencing participants' preference towards a device

differed by viewport dynamics ($\chi^2(4, N = 108) = 16.088$ and $p < .01$).

Looking further into this through subjective data, we found those participants preferred MVP videos primarily due to high immersion, excitement and emotionally engaging experience. On the contrary, our participants (17) constantly remarked that SVP videos are only good for documentaries, that are slow paced, explorative and does not demand high attention (e.g., `Refugee`). One comment was:

> *"For documentaries, I see a plus for static viewports and for all the rest you miss the fun...."* (P18)

4.2 Understanding Device Dynamics

In this section, we shift our focus on devices, and our objective is to answer - which device participants prefer to watch a 360° video and why. 55% of the participants selected a smartphone as their preferred device to watch a 360° video followed by a tablet (28%) and an HMD (17%). While their explicit ratings clearly showed a preference towards a smartphone, the SUS scores as illustrated in Figure 3(a) for the three devices were less conclusive - smartphone with $\mu : 75.83, \sigma : 9.63$, tablet with $\mu : 75.28, \sigma : 12.03$ and HMD with $\mu : 66.53, \sigma : 13.15$. Hence, we conducted one-way repeated measure ANOVA on the SUS means of the groups and observed a statistically significant difference ($F(2, 34) = 3.585, p < .05$) across the groups.

To examine this result further, we looked at three factors of these devices - *exploration, navigation and immersion*. We conducted a two-way contingency table analysis to see if these factors influenced participants' choices about using a specific device for watching 360° videos, and found a significant association ($\chi^2(4, N = 54) = 25.123$ and $p < .001$). Figure 3 (b) shows how these factors influenced participants' device preference.

Indeed, our interviews revealed that participants felt most comfortable with the mobile device due to the simplicity of the peephole exploration and familiarity with navigation technique (stop, fast forward, etc.) in a mobile. However, multiple comments (7) were raised regarding the ergonomic difficulties faced with the mobile, as participants mentioned that they wouldn't be keeping their arm raised for a long time. Tablets were primarily preferred due to the familiarity and its simple navigation controls.

However, it was mentioned (11) that since one has to click and drag around the screen to see different views, 360° videos are not immersive in a tablet, put extra burden and as a result the charm wears off quickly. HMD by far was mentioned as the most immersive device for watching 360° videos. In fact, 89% of the participants mentioned that HMD gives them a completely different sensation, and they feel as if they're actually in the scene as it unfolds before their eyes. One particular comment was:

> *"You are isolated from external elements. I no longer thought about the room I'm in ..."* (P1)

Also, with HMD users can explore the viewport more naturally. Multiple participants (4) mentioned that the exploration comes naturally to them in a HMD. We explicitly looked at participants' exploration characteristics over three devices. On average a participant exploration rate with HMD was 28° per 30 seconds, followed by mobile (21° per 30 seconds) and tablet (9° per 30 seconds). one-way repeated measure ANOVA test confirmed that that participants' degree of exploration 360° videos significantly differed by device types ($F(2, 34) = 4.745, p < .01$)

This result clearly suggests that a viewer will explore a 360° video more freely on a HMD. However, these natural exploration and immersion come at a high cost of poor ergonomics. All of our participants mentioned that the HMD was too heavy to wear, and they felt physically stressed. As we mentioned, one of participant quit the study after 30 seconds of wearing the HMD as she felt sick caused by motion, pixelated screen, and weight of the HMD. Furthermore, as mentioned earlier, sudden viewport changes without effective cues also contributes to cyber-sickness. Albeit these constraints, several of our participants (9) mentioned that if the weight of the HMD and screen resolution are improved, they would prefer HMD for watching 360° videos.

It was clear from our study that tablet (and as a generalisation a device with static position) is not immersive enough to emotionally engage the audiences with 360° videos. While, the mobility offered by mobile and HMD brings the engagement higher, it also demands dedicated physical setting, i.e., the very nature of the way a viewer explore the viewports of a 360° video would require rotatable seating furniture. This aspect was highlighted by multiple participants (11). One particular comment was:

> *"We need new furniture. I can't see myself using this in my couch. I need a couch that can turn.. . . "* (P7)

Similar comments were received from other participants. However, this personalised physical setting also has interesting social consequences. As one participant commented:

> *"With a box on your head, you miss the social aspect of watching a movie together, eating a snack, etc.. . .* (P18)

Videos - whether they are movies, sports, ads or otherwise - play a critical role as a social trigger to bring families, friends, and colleagues together by offering them a shared experience. With the advent of 360° videos and consequent demand for personalised setups, we see an interesting dynamics emerging here. With personalised rotatable seating arrangements, immersive content, and improved consumption device viewers will experience 360° videos uniquely. However, this engaging experience comes at the expanse of time spent on the social interactions while enjoying a video.

5 DISCUSSION & CONCLUSIONS

The study results gave us an illuminating picture of participants' experience of watching different 360° videos with various mobile devices. We briefly highlight a set of implications here that emerged from our study.

360° videos need guidance: Our participants preferred MVP 360° videos over SVP videos. In addition, MVP 360° videos triggered more interaction with the content by the participant. Therefore, we recommend using MVP, if the filmmakers prefer to have the users interacting with the content. Even so, we observed and initial 10 to 30 seconds exploration phase in the SVP 360° videos , we recommend to guide further interaction explicitly (e.g., as in `Waldo`) or implicitly (e.g., as in `Horror`) after the initial exploration phase.

Scene transitions need careful composition: MVP 360° videos are cognitively more demanding. Producers should carefully guide users attention to avoid abrupt VP changes (e.g., as in `Car` in 0:31 min.) This is particularly true for devices that offer a high degree of immersion (e.g., an HMD). In these cases careful VP changes are one important factor to reduce and avoid cyber-sickness. Similar as for the SVP 360° videos we recommend guiding users with visual or auditory cues to avoid bad VP changes. We have observed that videos with VP changing supported with one or multiple cues (e.g., in `Mountain` with the path and in `Car` with the road) are in general cognitively less challenging than free and fast VP changes in 3D space (e.g., as in roller coaster rides etc.). Therefore, we would also recommend to cut different versions of one 360° video with especially trimmed VP changes for the use on an HMD or mobile with dynamic peephole interaction.

360° videos need new entertainment constellation: Current HMDs are not ready yet to allow a smooth video viewing experience. Multiple technical challenges (e.g., screen resolution, form factor, weight distribution, etc.) need to be addressed to provide a better viewing experience. Even so, the 360° videos used in the study were just about three minutes long, the participants complained about the clumsiness of the HMD. Nevertheless, the HMD provides by far the highest degree of immersion. Overall, the dynamic peephole interaction technique on the smartphone provided the best viewing experience. Some participants also recommend to use a bigger device (e.g., the tablet) for the interaction, if the device is not heavy. In both cases (HMD and smartphone) participants also argued that both interactions would require rotatable new seating furniture in their living rooms. Past research has also uncovered similar insights highlighting swivel chairs offer superior viewing experience [15]. Indeed, we are already observing such new entertainment constellation emerging commercially for 360° videos, e.g., VR Cinema[6].

The results and observation presented in this paper should be taken in the light of the study conditions and the devices and thus may not necessarily be generalisable to all situations across all 360° videos. For example, our experimental settings did not include combination of SVP and MVP videos. We have reported both viewport compositions have advantages and disadvantages. In future we want to study the effect of combined viewport on users' viewing experience. Another limitation of our work is the content bias. Given, the selected videos are chosen from YouTube without any control on the story and emotional appeal, we have not quantified the content influence. However, we consider this is a fantastic route to follow in the future with respect to 360° videos and in particular assess the relationship of emotional attributes and users' viewing experience. Another potential area of exploration is the impact of users' posture and different environment constellations. In future work we also want to study the auditory component that naturally adds to the overall 360° video viewing experience.

To conclude, our results suggest that 360° videos with moving viewports trigger more exploration and offer superior viewing experience across all devices. However, these videos demand higher user attention, and can often cause motion sickness if viewport transitions are not composed carefully. Especially when watched on HMDs. The most interesting finding of our study is the fact that our participants preferred peephole interaction on a smartphone for consuming 360° videos.

While the general wisdom is that the HMD is the most suitable device for 360° videos, our study suggests that HMD is not ready yet to resonate with a mass audience due to higher cognitive burden, motion sickness and physical discomfort even so HMDs clearly provide the highest degree of immersion. Taken together these and the rest of our findings offer subtle guidelines towards immersive and dynamic visual experience with 360° videos on mobile devices.

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