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Proposal of a Virtual Reality Dynamism Augmentation Method for Sports Spectating

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***Abstract*—**It is common to see graphics appearing on television while watching a sports game to provide information, but it is less common to see graphics specifically aiming to boost spectators' dynamism perception. It is even less common to see such graphics designed especially for virtual reality (VR). However, it appears that even with simple dynamic graphics, it would be possible to improve VR sports spectators' experience. So, in this research, we explain how graphics can be used in VR to improve the dynamism of a broadcasted sports game and we provide a simple example. This example consists in a white halo displayed around the video and blinking according to the game speed. We hope to increase people's awareness about VR sports spectating and the possibilities this display offers through dynamic graphics.

***Keywords*—**Broadcasting, graphics, sports spectating, virtual reality.

I. Introduction

MANY researchers and designers are working on new graphics for sports broadcasting to improve remote spectators' experience. However, these graphics are usually used to display information and rarely aim to improve dynamism. These graphics are often animated and colorful to attract the spectators' attention, but despite their lively appearance, they are not designed nor adapted to optimally enhance the dynamism of the game. Furthermore, while broadcasting companies are focusing on improving their content for television, there is a lack of research in broadcasting via VR. Despite the popularization of VR, very few research works have been focusing on the improvement of VR sports content.

VR is an immersive and lively display that offers more possibilities compared to television. New improvement methods can be developed in VR so that broadcasting companies can attract a new type of spectator: VR sports spectators. Furthermore, with the improvement of VR broadcasting services, we can hope to make this display type more accessible and attractive. So, in this research work, we propose solutions to improve VR sports content using dynamic graphics. We hope to increase awareness about VR's potential as a broadcasting media and encourage the popularization of this display.

In this paper, we develop the benefits of using VR for sports broadcasting and how graphics can be used to improve VR users' experience. To do so, we focus on dynamism enhancement and explain how graphics can be used to augment the dynamism of a sports game. We finally give an example of simple graphics we specifically designed to augment dynamism.

II. Background

To improve spectators' enjoyment and experience, we explained in a previous study that display technologies can be used to improve enjoyment parameters such as game understanding, identification to players or teams, etc. [1] Researchers have largely developed methods to improve these parameters [2]-[6], except the dynamism parameter. Depending on how dynamic the game appears to the spectators, their enjoyment can vary. However, this parameter has been poorly investigated. So, in this research, we propose to focus on it.

We generally define a media content as dynamic when it is full of energy, changes, and movement. So, for sports games, a game feels dynamic depending on factors related to speed, progress, movement, and intention. For example, the game progress, the game speed, the players' vigorousness, and so on can be good indicators of the dynamism of a sports game. However, it can also appear more dynamic when external factors introduce additional energy and movement. For instance, the camera movement, the commentators' comments, the lights on the venue, or the graphics displayed can add another dimension to the dynamism of a broadcasted content. Among these external factors, we propose here to use graphics to influence the dynamism perception of remote sports spectators. Indeed, Mourey and Elder[2]show how incorporating dynamic elements in a media content can add dynamism and influence positively the viewers. Moreover, in our previous study [1], the results of a survey revealed that people wished to improve the aesthetic and dynamic aspect of sports games using display technologies, and the most popular display for this purpose turned out to be VR; 59.6% wished to improve this aspect, and 31.9% voted they would preferably use VR. Indeed, to watch sports games remotely, VR seems to be the best display to convey dynamism. Previous research works showed that when watching content using VR, the brain activity, in particular β-waves, is stronger than with a television [3]. It can be understood that the content watched in VR is perceived as more dynamic. Furthermore, Kim and Ko [4] show that VR improves spectators' experience via vividness among other factors. So, it seems that content displayed in VR is

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perceived as more dynamic than when displayed on television and can be more enjoyable. Thus, to improve the dynamism of sports games, we propose displaying dynamic graphics in VR.

III. Related Works

Some researchers studied the factors influencing dynamism and their effects on people, but their research works rarely focus on sports spectatorship [7], [10], [11]. For studies concerning graphics applied to sports spectatorship, they generally do not consider the dynamic aspect.

Some research works in the marketing area explain how dynamism can be used to influence people's opinions about a product or their consumption behavior. For example, Mourey and Elder [2] explain that dynamic elements can improve people's ratings. More precisely, they show that improving the dynamism of commercials by changing the color saturation or introducing movement can influence positively people's judgment and be more arousing. Wang et al. [5] and Roggeveen et al. [6] also show that when exposed to dynamic content people tend to consume more in contrast with static content. So, we understand how improving dynamism through movement and color variations can have positive effects on people. In this case, dynamic and colorful graphics can be useful.

When designing graphics, the main purpose is usually to support game understanding like in [7]. Yet, it can be noted that the graphics implemented in sports broadcasted programs are getting more and more dynamic. The graphics used for Super Bowl games are a good example. An article [13] published on the NewscastStudio website presents the new graphics package of CBS Sports Network used to broadcast the Super Bowl event. They are animated and very colorful, so they undoubtedly add dynamism to the content. Even if the first aim is to provide the spectators with useful information, we can notice a secondary intention to enhance dynamism.

Even if sports broadcasters did not fully exploit the potential of dynamic graphics yet, amateurs already explored this possibility. When browsing the Internet, it is easy to find amateur videos augmenting sports events using visual effects such as flames and lightning [9]. Amateur visual effects show interesting improvement possibilities but are generally quite overwhelming and cannot be applied to professional broadcasting. Indeed, Mourey and Elder's research works [2] show that when the dynamic element is too intense, the viewers may feel annoyed and lose enjoyment.

Finally, it appears that in the current state, dynamism is poorly exploited to improve broadcasting services. So, as a first attempt to improve sports dynamism using graphics, we propose to design simple graphics using the recommendations of the articles cited above ([2], [5], [6]). We propose to display a white halo blinking around the sports video according to the game speed in VR. We explain below how we choose to configure this graphic and how it is supposed to augment dynamism. The appearance is shown in Fig. 1 and a short explanation video is provided in [10].

IV. Example of Dynamic Graphics

A. Principle

We aim to design a simple dynamic component that would positively influence the game dynamism perception of the subjects without distracting them or affecting their enjoyment.

In this article, we apply graphics to handball videos since it is a dynamic sport with fast actions and progress, but any sport with a dynamic dimension would also be suitable.

As suggested in [2], the dynamic graphics should be based on movement and color variations. Wang et al. [5], Roggeveen et al.[6], and Kaneko [11] develop how movement can improve the viewers' experience. For color variations, even if color changes could be used to influence dynamism, we choose here to focus on brightness and not on saturation or hue to avoid conveying unwanted messages. Singh [12] and Naz and Epps [13] explain that colors can constitute a source of information and be interpreted, so they can influence viewers' perception without being linked to dynamism. However, incorporating brightness variations could influence the dynamism perception without conveying any sort of message. Amorim's study [14] shows that lighting can influence people's arousal, stress, or relaxation. So, for an increase in brightness, we expect an increase in arousal and dynamism perception. For these reasons, we choose to use animated white graphics and introduce brightness variations to specifically focus on dynamism.

To fit the content and efficiently improve dynamism, we propose to configure the dynamic element's variations in accordance with the speed of the game. Indeed, augmenting dynamism at a slow and flat moment of the game would not make sense and could even create an unpleasant dissonance and distract the spectators. So, to estimate the dynamism variations of the game, we choose to focus on the game speed since we think it is a good indicator of the game dynamism. Other dynamism factors could be used such as the players' aggressivity or the progress speed, but the game speed appears easier to estimate.

We estimate the game speed and make the graphics following the game speed's variations to match the content. Items such as the frequency of events (point scoring, dribbles, passes, etc.) or the velocity of the players are easy to calculate and seem to provide a reasonable estimation of the game speed. Metrics such as players' relative velocity, peak velocity, or accelerations are often used to analyze matches or players' performances in previous research works [15]-[18]. However, these metrics have never been used to evaluate game dynamism so we cannot guarantee their efficiency to estimate dynamism. Furthermore, they require complex instrumentations such as global navigation satellite systems (GNSS) and video-tracking systems. Thus, for our prototype, we choose to estimate the game speed of sports videos using a basic method we develop below.

Based on the above observations, the chosen dynamic element is a white blinking halo displayed around the video. Only the white color is chosen to keep a neutral message. The halo is displayed around the video to stay in the field of view

without interfering with the video. The blinking motion integrates a notion of movement. The blinking frequency is configured to vary according to the game speed to stress the dynamic characteristics of the game: suspension, game speed, and shots. When players are running, the halo blinks with a frequency depending on the game speed of the ongoing action. When players do not run, the halo does not appear since there is no action to stress. When blinking, the halo has a frequency proportional to the game speed of the current action.

A video of the interface and halo developed is provided in [10].

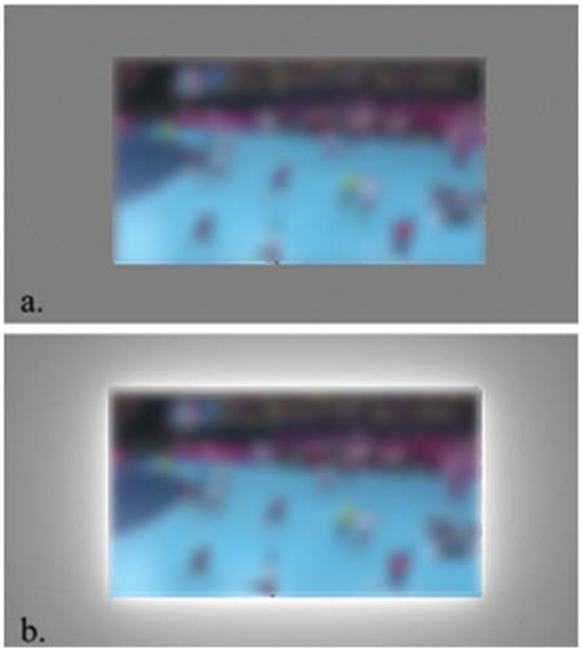

Fig. 1 Halo appearance: (a) video without any halo, (b) video with the halo

B. Halo Characteristics

The halo is designed to be subtle but bright and fast enough to augment dynamism. We use the Bloom effect of Unity software since this effect creates a natural and subtle halo. This effect is usually used to simulate light overwhelming a camera lens. Furthermore, preliminary tests have been conducted to determine what range of brightness and blinking frequency is suitable, not too subtle but not too aggressive. The tests have been conducted using an Oculus Quest headset.

After testing, we chose to set the halo characteristics as follows: On Unity2018 software, the effect Bloom creating the halo is set with an intensity of 22, a threshold of 1, and a color expressed in HSV color space as (0, 0, 100) for a high-brightness condition. When blinking, the post-process volume weight oscillates between 0.5, halving the effect, and 1, resulting in a full effect. The default directional light is used in the scenes. The appearance of the halo is shown in Fig. 1.

After testing the halo on 10 different professional handball extracts, we advise setting the blinking frequency-game speed coefficient to 1.5 for a reasonably fast blinking for handball games.

For the tested videos, we estimated the game speed of a period as the number of events such as dribbles, passes, or shots divided by the duration of the period considered (e.g., 1.2 events per second). The game speed of these professional handball games was about 0.6 events per second. But it equaled 1.6 events per second on average for intense moments and could reach 2.5 events per second for more intense ones. So, with a coefficient of 1.5, the blinking frequency would be equal to 2.4 Hz on average for intense moments.

We invite the reader to watch the video provided in the references to visualize the resulting effect [10].

V. Limitations and Future Work

We remind that we configured the halo blinking frequency for handball games. For other sports, it is possible that the optimal blinking frequency will be different. So, before using the halo for another sport, tests are recommended. Also, we used an Oculus Quest headset to test the halo. However, the Bloom effect render can slightly vary depending on the display used. If someone wants to reproduce our graphics, this point should be considered.

Finally, the graphic's style and configuration have been designed for VR, but it would be still possible to adapt it for a 2D screen. In this case, the blinking light can hardly be displayed around the video, so we suggest displaying it in a more practical area, such as the lines of the field. Considering VR emphasizes the dynamism compared to television, the brightness and the blinking frequency may need to be more intense to produce the same effects as in VR. An example of an adaptation of the proposed graphics is given in Fig. 2.

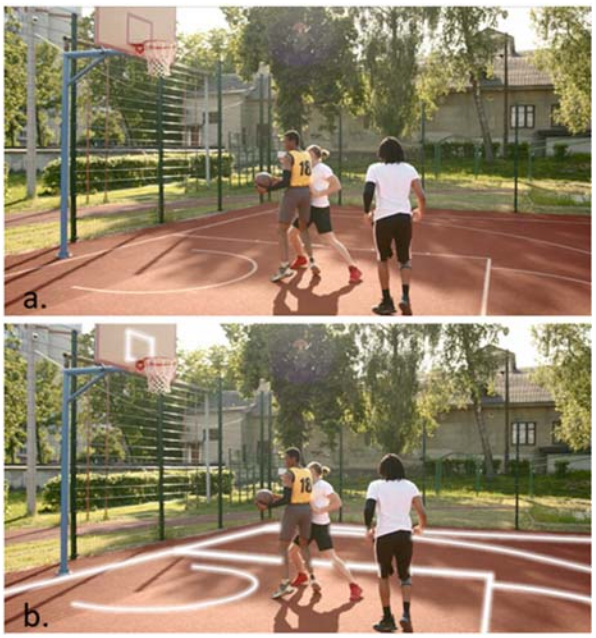

Fig. 2 Example of another dynamic graphic, more adapted for 2D screens: (a) video without any graphics, (b) video with graphics

An experiment testing the effects of the graphics when displayed in VR is being conducted, as well as an experiment

comparing the effects of the halo proposed in Fig. 2 between VR and television. We hope to release the results and provide a conclusion about the efficiency of dynamic graphics in sports spectatorship very soon.

VI. Conclusion

In this paper, we explain the assets of VR for sports spectating and how graphics can be used to improve game dynamism. Dynamic graphics should be based on color variations or movement to target dynamism improvement, but developers should be careful not to make it too intense, or the graphics could harm spectators' experience. Considering these remarks, we propose to display in VR a white halo around the sports video blinking according to the game speed. However, the graphics would require adaptations if used for another sport or 2D screens.

We plan to release the results about the effects of the proposed graphics soon.

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