Theorized Work for Adapting the Principles of Animation to Virtual Reality as a New Form of Narrative for 3D Animation

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Keywords: Virtual Reality, 3D Animation, Principles of Animation.

Abstract: In this paper, we will for starters, introduce the basics concepts of virtual reality, how it works, which its upsides and downsides are, followed by the contextualization of the twelve principles of animation then we open a discussion about how we can adapt it for the media of virtual reality. The goal of this research is to create a discussion about the utilization of virtual reality as a new form of narrative for third-dimensional animation and how we can improve the adaptation of standard animation concepts to a new form of media.

1 INTRODUCTION

Due to the success of productions, producers might look for new ways to increase the reach of their products, like redesigning it to another type of media beyond the traditional ones like cinema or television. This is the transmedia process that happens when the source of the content is explored in another type of media, like going from comics to movies or games (Jenkins, 2007).

Nowadays there are multiple examples of transmedia, we see it in products like Harry Potter, with books being transformed into movies, Lord of the Rings having its source material, the books, being turned into oscar-winning movies. But a book to the screens isn't the only form of transmedia, Harry Potter has also been delivered to the world of games, the same we can speak about Lord of the Rings, and in the case of games, the user stops passively interacting with the source material and starts being a piece of the interactive narrative.

One of the recent technological advancements is the fact we are utilizing virtual reality hardware as a new type of media. This technology creates a mental immersion on the user, putting them inside a simulation, or a virtual world (Sherman; Craig, 2003).

Not only games and traditional media content are being adapted to virtual reality, but also applications for training in medicine (Machado et al., 2011; Soares et al., 2014; Vaughan et al., 2016), engineering laboratory (McCusker et al., 2018), education (Zhang et al., 2018), readiness against earthquakes (Lovreglio et al, 2018).

Since its beginnings, animation has evolved alongside the technology, being presented in old technologies like the thaumatrope, phenakistoscope, and zoetrope, until arriving at the current media of cinema and television (Sutton, Williams, 2009).

Google tried to explore animation in virtual reality with the project called Spotlight, which is a project of 3D animated stories in virtual reality using 360 degrees, with projects like Age of Sail, based on history by William Avery. They also developed Back to the Moon, in celebration of George Melies and his movie A Trip to the Moon.

Considering that virtual reality is being used in other areas of research, and animation has historically been tested in new types of media the idea of the research is to create a procedure to adapt traditional 3D animation to virtual reality to create new forms of narrative for animation. To do this, we need first to discuss empirically how we can start to adapt 3D animation concepts to the media of virtual reality so we can understand the core problem of this proposition to create new forms, techniques, and procedures for the narrative in the animation.

In this paper, we will for starters, introduce the basics concepts of virtual reality, how it works, which its upsides and downsides are, followed by the twelve

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Salomão, A., Vieira, M., Romeiro, N. and Nassar, V.
Theorized Work for Adapting the Principles of Animation to Virtual Reality as a New Form of Narrative for 3D Animation.
DOI: 10.5220/0010338303080312
In *Proceedings of the 16th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2021) - Volume 1: GRAPP*, pages 308-312
ISBN: 978-989-758-488-6

principles of animation discussed by Ollie Johnston and Frank Thomas in the book Disney Animation: The Illusion of Life (1981). Then we will open a discussion about how we view the principles of animation that can or cannot be adapted to the uniqueness of virtual reality and the ideas we have for the next step of this research.

2 FUNDAMENTALS

First, we will approach the necessary fundamentals knowledge necessary to discuss virtual reality and animation principles.

2.1 Virtual Reality

Virtual reality is a technology that is growing in popularity, being used in entertainment, but also research education, and training (Zhang, M; Zhang, Z; Chang, Y. 2018).

Even though the concept of virtual reality can be backtracked to 1960 with Ivan Sutherland (Cipresso et al. 2018), for the sake of the proposed discussion in this article, we will be using the definition and system proposed by LaValle (2017) for virtual reality that uses the following concept.

- Artificial sensory stimulation is used to induce targeted behavior in an organism, while the interference remains either imperceptible or hardly perceptible.

LaValle also creates an image concept of how the virtual reality's system is supposed to work, having the connection between three components, the organism, the physical world, and the hardware, and how they connect and/or interact with each other, the image concept proposed by LaValle can be seen in Figure 1.

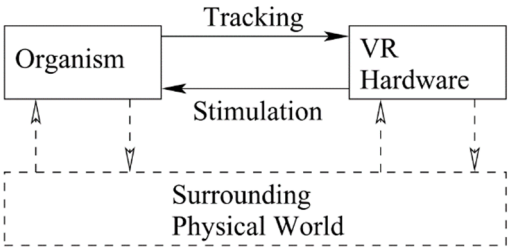

Figure 1: Schematics of LaValle's concept (2017).

Virtual Reality has its limitations considering design choices, in the virtual world, it is suggested that the scales should be as faithful as possible to the real world, to let the user be more familiar with the depth and perspective and navigate it more naturally without discomfort. It is advised to avoid designing environments where much user movement is needed. Concerns about the visual render are first that the only difference between the left and right visions must be the user's point of view and nothing else. All the UI must be incorporated in the virtual world and not be something fixed. The rendering system must be optimized to assure a constant frame rate. Avoiding the illusion of undesired movement, and do not make the camera move when the user is not moving. When camera movement is needed to make the impression that the user is moving, as a rollercoaster simulation, as an example, it must be done carefully so it does not give the user side effects (Salomão, 2020). Nolan *et al.* (2017) say that every camera movement is perceived as a user sight moving, implying that any movement not controlled by the user may cause discomfort.

It is of importance to understand and comprehend the negative effects of virtual on users and why it can happen for the safety of the user (Jerald, 2015), otherwise as researchers and workers in this field, we will not be able to create a hypothesis, ideas, and design solutions for 3D animation in virtual reality that can be feasible for the end-user.

For this article, we will consider, for the sake of discussion, the organism to be the user, the Head-Mounted Display (HMD) as the hardware for virtual reality, and the physical world, a workplace where the user will be interacting with the virtual world.

2.2 Animation Principles

As stated beforehand, for this study we will consider the twelve principles of animation by Johnston & Thomas (1981), two senior animators of Disney Studios written in the book Disney Animation: The Illusion of Life, as a starting point for the discussion of adapting 3D animation to the media of virtual reality.

The first principle *Squash & Stretch* means to squash and stretch the objects during their animation to give the sensation of the flexibility of it. In animation classic cartoon animation by Disney, this effect was exaggerated to cause a comic effect, while in realistic styled animation, the volume of the object must be balanced between both concepts.

Then we have the principle of Anticipation intending to make actions more realistic and avoid the abrupt initiation of movement. For example, the act of inspiring air before blowing it on a candle is necessary this movement of inspiring the air so the audience is prepared for what is about to happen and doesn't miss the joke or the meaning of the scene.

Following anticipation, we have the principle of *Staging*, where the idea is that every scene in the animation has a purpose, and the composition of this scene has to meet the needs of this purpose, working to direct the audience attention and not leave the open interpretation of what is happening, unless that is the point of the scene.

The fourth principle is the combination of Straight Ahead Action with Pose to Pose, the first being an animation technique where the frames are drawing in sequence as the action is being developed while the second consist of first drawing the necessary keyframes of the animation and then the in-betweens of it

The fifth principle is also a combination of Follow Trough with Overlapping Action, which defines the form in which the object's body does not stop moving immediately once the action is concluded, and that they are attracted to the gravity's center of the character, creating progressively a more natural and fluid animation.

Slow In and Out as a principle works with the acceleration and slowdown of objects, the goal is to avoid the movement to seem robotic and unrealistic by adding a slow in effect at the start of the movement and a slow out effect when stopping the movement.

The seventh principle of animation is Arc, the idea is that natural movements from an organism can be usually represented by an arc, like the walking cycle of a human character. The principle consists in to avoid using linear movements since those usually cause an effect of the character being rigid, instead of by using an arc movement, it has a more fluid and natural movement.

Secondary Action as the eighth principle works as an adjunct to the main action of the character, which means that it cannot be more important and take the attention of the viewer out of the main action. For example, in a scene where two characters are talking, the gentle gesture of the hands of one on a table cannot overtake the main action otherwise the viewer will not pay attention to what is being said.

To dictate the rhythm of the animation we also have Timing as a principle, referring to the number of frames used in determining action, dictating the pace of said action, and making it more physically realistic, such as in an animation of a character running, where fewer frames will be used to present the idea of speed.

The tenth principle, Exaggeration, to make the actions more entertaining, exaggeration is applied to expressions, actions, and overall elements of the scene, making the eyes bigger to express surprise, or making the character melt to demonstrate heat are examples of how this principle is applied to animations.

Animation at the start, being mostly 2D, also used a lot of concepts and ideas from drawing, that is what the eleventh principle of animation is about, Solid Drawing, the idea of making the drawing not appear as flat, giving it volume, using light, shadow, perspective and avoiding showing asymmetric character.

Lastly, we have Appeal which presents the idea that a character must be designed to be charismatic, with the objective of the spectator liking and bonding with it, drawing the character with baby-like facial features tends to make them more appealing to the audience than one with complex facial features.

3 DISCUSSION

John Bucher (2018) after interviewing Jessica Brillhart, a filmmaker for project Spotlight, took as concepts for animation in virtual reality that engaging with the user feels more like a dance than a forced experience, characters can work as vessels for the story, traditional narratives structures like three-act might be used, but not entirely as it is, among other discovery.

The twelve principles of animation by Johnston & Thomas were developed during years of work in the Walt Disney animation studios, it was also done using the traditional type of media, a two-dimensional plane, to explore the narratives of an animation.

Virtual reality brings a new dimension, the possibility to work with a tri-dimensional plane, or to explore the two-dimensional plane with a 360 degrees video, which enables the possibilities of new concepts being developed.

These new concepts for 3D animation can be done by creating a virtual world, like an ordinary game in virtual reality, that runs in real-time, or more in line with a traditional animation that runs as a pre-rendered work that is being displayed to the user.

So, considering the possibilities of virtual reality, the first principle of Squash and Stretch can be explored in the immersion sense. What this means is that, even though the concept itself does not change, we can give it more depth and scale, which means, for example, things that stretch can go beyond the two-dimensional plane by wrapping the user in the movement of the object, and since he is also immersed in a virtual world. The same idea can be applied to the principle of Secondary Action and Anticipation, we can go beyond the boundaries of a two-dimensional plane and enhance the impact of the

principle, improving the experience and the way the narrative is told.

The staging principle works a lot of the time with camera cuts, with the idea to bring the attention of the user to a narrative event. But how to properly do that in virtual reality? In both proposed scenarios, the user can just spin his head around and completely miss an important moment of the story. One proposition we have is the use of environmental elements to redirect the user's attention to the point of narrative focus. This is done already in open-world games especially where in an open-space the game has to guide the player in a certain direction so he can progress with the game, the same can be applied to animation in virtual reality.

If we think of the development of animation in virtual reality as the development of a game, we will see that both use the same form of animation, Straight Ahead Action and Pose to Pose, as necessary. Virtual reality does not seem to influence this animation principle at first glance, since it is the result that affects the user and his experience. But in case the animation runs in real-time in the virtual reality experience, we suggest looking into studies about the performance of the animation effects if done by interpolation or frame by frame on real-time rendering to see if it has a meaningful impact to the point where one technique might be more reliable than the other for a better chance of having locked frames per second to not cause health issues to the user.

The same performance issues can be the case for the principle of Follow Through & Overlapping Action and Arc. With current hardware limitations in virtual reality, these principles can be removed entirely to increase the performance of the animation, considering this principle can be notoriously seen in hair movements, and those require an extra amount of power to animate properly even in non-virtual reality environments. The necessary Arc movements of characters for example might be less fluid due to the nature of having models with lower polygons count.

Regarding Slow In and Out, alongside the principle of Timing, here we must take extra care especially in certain situations, it might make or break the experience for the user. Traditionally, both principles oversee different aspects of the timing of the animation, and timing in virtual reality is crucial for certain situations like for example, let's theorize a scene where the player is following the main character in a car, because of the immersion effect virtual reality has, animating the speed up and the slow down of the car is not something we can just ignore and remove from it like the previous principle. If in this scene, the car suddenly stops out of nowhere instead of slow down, the abrupt stop of it could jar the user and cause side effects on his health. The same can be said for the opposite, if for example, the environment of the animation speeds up for whatever reason, it might also cause a disorientation effect.

In animations, it is often that characters, environments, and the animation itself are exaggerated, but as we theorized with Squash & Stretch and Secondary Action, it is bound by the media it is in, there is so much exaggeration we can fit into a two-dimensional plane screen. In virtual reality, the possibilities of exaggeration are limited by its virtual world and how much you can do it without having a performance impact, finding the balance of performance and narrative impact is key to use this principle properly in animation for virtual reality.

The Solid Drawing principle of animation is related to the concepts of drawing and how important it is to follow it to create a proper drawing for animation. Even when working on 3D animation, the result is demonstrated in a two-dimensional plane, just like hand drawing. For virtual reality, it is important to keep the virtual world in scale with the real world, a different scale can cause health issues, that is where the importance of Solid Drawing shows in virtual reality, keeping the object on a scale and in check of what the user expects to be real to avoid health issues.

Lastly, Appeal can be seen as the culmination of all principles being properly applied to the animation, true assessment of the Appeal principle on animation in virtual reality can only be checked or studied properly once every principle has been tested to exhaustion. It is entirely possible that by studying every principle, we might even see new concepts or ideas for what is considered appealing for the virtual reality's user.

4 CONCLUSIONS

It was presented in this paper the idea of needing to first discuss empirically the adaption of the principles of animation as the first step to create a new procedure for the development of new or adaptation of 3D animation in virtual reality.

The conclusion is that the adaptation of the principles of animation for the media of virtual reality will require a better understanding of the limits imposed by the selected hardware.

We see examples like Squash & Stretch, Anticipation, and Secondary Action where virtual reality might help create new creative ways of

applying those concepts due to the fact of the animation not being bound to a two-dimensional plane and instead of being on a tri-dimensional plane.

We also see principles that instead be restricted in virtual reality, like Follow Through & Overlapping Action and Arc, due to the limitation of the hardware. Both animations require more polygons to have a fluent animation, and in virtual reality, there is a tendency of reducing them for performance's sake.

The reality is that even though we can theorize good and bad applications of the principles in virtual reality, it is necessary to do more applicated research on this topic to narrow down the issues in each case, and consequently, find solutions to problems and creative innovations to create a better experience to watch 3D animation for the viewer.

Just as 2D animation principles had a transition period to 3D, one is also necessary for virtual reality to create a feasible product for the end-user, be it animation for entertainment purposes or as of help for society.

ACKNOWLEDGEMENTS

We thank the Federal University of Santa Catarina. The financial support of CAPES and FAPESC. And the team in DesignLAB/UFSC and Tecmidia for the collaboration to this research.

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