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Virtual Production:

A closer look at digital innovation and health

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Abstract. This article focuses on a research project about Virtual Production which was developed during a research scholarship program at Polytechnic University of Cávado e do Ave (IPCA). This project aims to implement Virtual Production (VP) technology in the academy to prepare students for a future generation of creatives capable of responding to industry needs. This project partnered with the University of Minho and the "Descomplica" Project aiming to develop a one-minute video about Post-Traumatic Stress Disorder (PTSD) using VP technology with the objective of raising awareness about this disorder and break the stigma around it. The article also discusses the potential of VP to revolutionize content creation and democratize filmmaking as well as its applications in the healthcare sector, especially in education, medical and patient care training. This article concludes by emphasizing the importance of continuing to explore the possibilities of VP while addressing its challenges and limitations in order to create an accessible, effective health system and more effective for everyone.

Keywords: Virtual Production, CGI, VFX, Mental Health, Post-Traumatic Stress Disorder, Speculative Design

1. Introduction

This article was developed during a *Summer School Research and Development* (SSR&D), that took place at the Polytechnic University of Cávado e do Ave (IPCA), with the support of a scholarship grant. This SSR&D is a university program with a three-month duration that aims to stimulate multidisciplinary learning and research methodologies with a focus on exploring responses to specific concerns in the general area of health, to raise awareness or to prevent such problems.

The main focus of the project developed during the SSR&D was to implement Virtual Production (VP) technology in the academy, motivating schools to invest in new programs and courses, preparing students as the future generation of creatives, capable of responding to the industry needs, and also to determine the best strategy for advancing VP studios as an innovative and very recent technology.

Within the scope of this project, and considering the health theme of this research, it was decided to create a partnership with the University of Minho and the *Projecto "Descomplica*" (Saúde Mental: Projeto Descomplica, 2022) in order to develop research on what could better intervene in the health area. This partnership focused on creating a technical one-minute video about Post-Traumatic Stress Disorder (PTSD), made with VP technology, that could bring awareness to this disorder and break some of the stigma around it.

PTSD is a mental illness that can arise in persons who have encountered or seen a traumatic event, sequence of events, or combination of circumstances such as, for example, natural catastrophes, major accidents, terrorist activities, war, combat, rape, sexual assault, historical trauma, intimate relationship abuse, and bullying. This can

be emotionally or physically detrimental, life-threatening to an individual and/or impact on their mental, physical, social, and/or spiritual well-being.

People suffering from PTSD have powerful, unsettling thoughts and sensations about their traumatic experience that remain long after the incident has passed. They may relive the incident in flashbacks or dreams, experience grief, dread, or fury, and feel disconnected or estranged from others. People suffering from PTSD may avoid circumstances or persons that remind them of the traumatic experience, and they may have significant unpleasant reactions to seemingly innocuous things such as a loud noise or an unintentional touch (Taylor-Desir, 2022).

2. Virtual Production

The COVID-19 pandemic has caused massive social unrest and unprecedented consequences and changes in lifestyle, work, and social interactions. Social distancing measures were implemented, quarantining people in order to limit human interaction at the height of the pandemic. People were forced to stay home, shelter in place with their families, and restrict contact with the outside world. This has led to a need for more entertainment options, as people were dispensing more time with video games, movies, and series, to help cope with isolation. This new pressure on the entertainment industry as well as new regulations regarding confinement and social distancing caused companies to develop and indulge in new technologies. VP falls into the scope of these new technologies by providing more freedom and flexibility, while reducing in-person interactions between individuals, creating a more secure atmosphere during the COVID-19 lockdown (Arkenberg et al., 2023). As such, VP, throughout this crisis, opened to the potential for the increase of employment and content creation while improving sustainability, calling the attention of content producers in the entertainment industry for its many advantages (Pennington, 2020).

2.1. What is Virtual Production and what is it used for?

Virtual Production (VP) is a cutting-edge filmmaking method that combines traditional physical production techniques with the latest advancements in technology. By utilizing advanced computer graphics and real-time technology, VP allows filmmakers to create complex, photo-realistic environments and characters in a virtual world and then integrate live-action footage seamlessly into the final product, something that has. This has broadened the scope of storytelling and cinematography in several ways and has currently been successfully used in movies and television series, such as *The Mandalorian* (2019-present) and *House of the Dragon* (2022-present), as seen in Fig. 1.

Fig 1. Images from the filming sets of The Mandalorian (left) and House of the Dragon (right) and their use of Virtual Production Technologies. Retrieved from: https://postperspective.com/workflows-house-of-the-dragon-and-coalescence/ and https://techcrunch.com/2020/02/20/how-the-mandalorian-and-ilm-invisibly-reinvented-film-and-tv-production/.

2.2. How does Virtual Production work?

As briefly mentioned above, VP is a revolutionary process that meshes the traditional world of filmmaking (actors, props, etc.) latest advancements in technology (lighting, VFX, etc.) in one method. It allows filmmakers to create complex, realistic environments, and characters in virtual worlds, and seamlessly integrate live action scenes into motion pictures. The main process behind VP is the integration of different technologies such as CGI,

motion capture, facial recognition, laser scanning, robotics, and augmented reality (AR) on a single platform. Typically, this is achieved using Unreal Engine[1] and software like ILM's Stagecraft[2] (DeGuzman, 2023).

VP is achieved through the use of led walls that project images generated by a computer. These projections can be used to create sets, backgrounds, and interactive environments that appear realistic onscreen. Additionally, led walls are often used in conjunction with augmented reality, which adds extra layers of interactivity to scenes (Breitman, 2022). The field of VP includes many different methods and solutions that can be applied to different situations, all of which share the common denominator of a real-time game engine. Some of these solutions are (Pires et al., 2022):

- Visualisations – a form of visual modelling created to convey the creative intent of a shot - such as Pitchvis[3], Previs[4], Postvis[5], Techvis[6];
- Virtual Scouting – The process of exploring digital environments in virtual reality. This technique provides allows to navigate and interact within a virtual set, allowing for better creative decisions and shot planning.
- Green screen or Chroma Key – unlike visualization, are used during recording and allow live action composition techniques. Here, a camera tracking system can provide data that allows the projected backgrounds to change perspective according to camera movements in the physical world, creating parallax synchronized with both the virtual and physical cameras. As with visualization, results can be viewed on a screen or using virtual reality headgear to gain better spatial understanding of the combination of the physical and virtual environments;
- Full Live – a channel for hybrid VP output has also been introduced and requires the composite image to be of final pixel quality and sent to the stage on the led wall;
- Motion Capture – the process of capturing the movement of objects or actors and using this data to animate digital models and be integrated into the realm of VP as a technological advance that enables real-time movement capture;

There is a natural overlap between this different solutions, and one type is rarely used without the others. The truth is that these approaches are becoming so intrinsic to film production that modern screenplays have assumed some form of virtual integration. And even low-budget productions are starting to benefit from more affordable of commercial gear.

In Fig. 2 we illustrate how the VP pipelines are structured, and how it influences the rest of the filmmaking process, showcasing how it allows for better experimentation during the pre-production and visualizations phases.

[1] Unreal Engine is a real-time 3D engine built for the development of cutting-edge games, real-time visualizations, and realistic immersive experiences.

[2] StageCraft is a location-based virtual production, vfx system created by Industrial Light & Magic (ILM).

[3] Presentation or visual presentation used during the pitch process.

[4] A preliminary animation or 3D representation created before a film or video game scenario is shot or produced.

[5] A stage in filmmaking or animation in which temporary visual effects are created, frequently utilizing rough or placeholder graphics, to help in the post-production process.

[6] A document that details the technical and visual components of a film or video production, such as camera placement, lenses, lighting, and special effects.

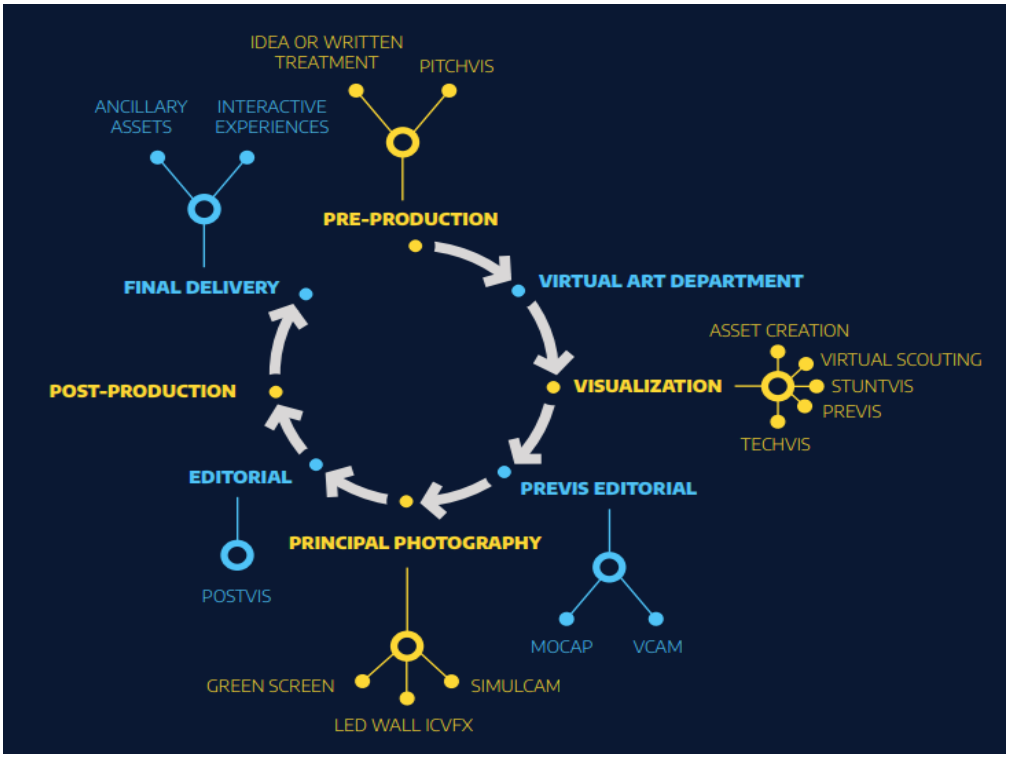

Fig 2. An example of a typical Virtual Production workflow. Retrieved 9th September 2023 from: https://massive.io/workflow/virtual-production-workflow/

2.3. Benefits of Virtual Production

VP represents a paradigm shift in filmmaking, bringing countless benefits that help optimize production processes and enhance creativity, ushering a new era and revolutionizing the way stories are presented on screen (Breitman, 2022, Wall, 2023). The way the VP pipeline is structured, and how it influences the rest of the filmmaking process, allows for better exploration during the pre-production phases, while offering several distinct advantages over traditional filmmaking methods, as seen in Fig. 3. This enables the applications of visual effects during pre-production, rather than relaying them to post-production, facilitating for a smoother integration of computer-generated (CG) and live-action elements and thereby reducing the heavy workload in post-production (Wall, 2023).

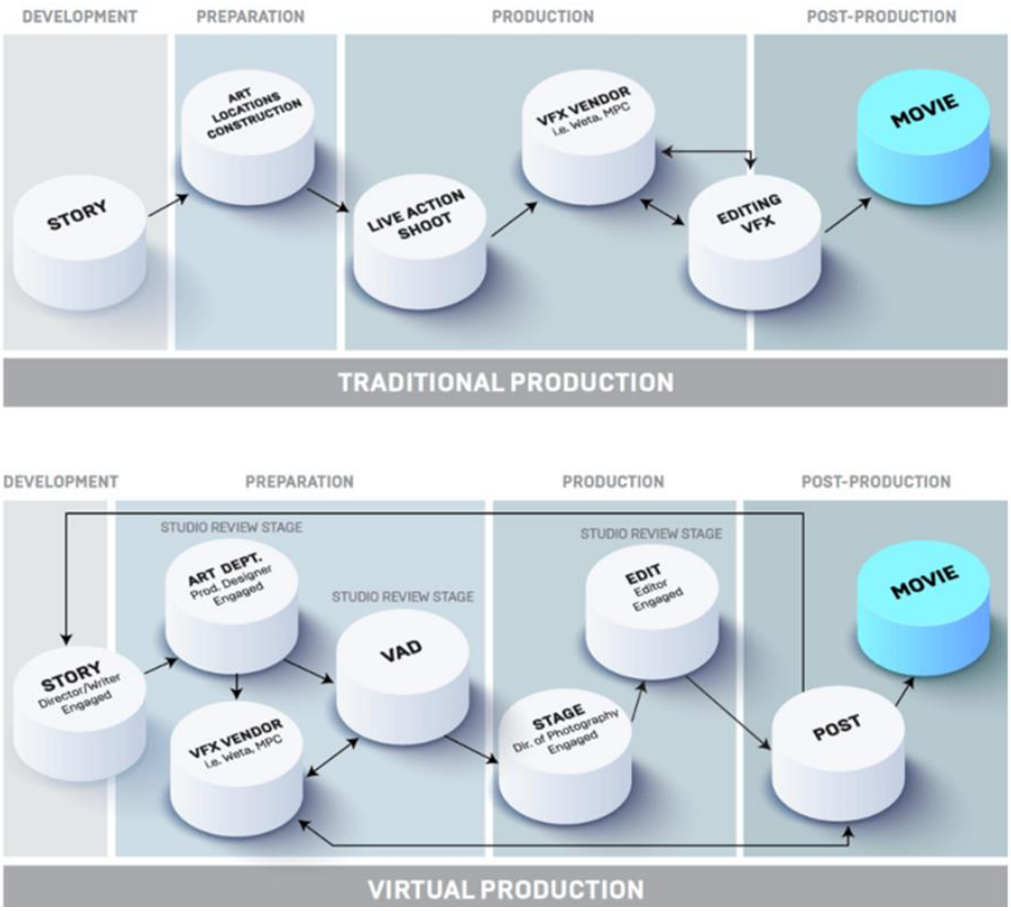

Fig 3. Traditional Production vs Virtual Production pipeline. Retrieved 9th September 2023 from: https://www.cgspectrum.com/blog/how-does-virtual-production-work

VP gives directors more control over many aspects of their production in real time, from setting camera angles and lighting to controlling special effects, giving them increased creative influence over each aspect of the process. Further, VP also enhances actors' performance by immersing them in virtual environments with realistic visuals and motion capture data. This immersive experience allows actors to interact convincingly with digital elements, delivering immersive and engaging performances. Pre-production rehearsals are facilitated without the need for elaborate sets, allowing the actors to thoroughly refine their characters and scenes. Real-time monitoring tools also allow actors to evaluate their performance on-site, reducing the need for frequent interruptions while viewing footage. The combination of these elements will result in more natural and engaging performances that more closely simulate reality (DeGuzman, 2023). This promotes better collaboration and communication between teams, while improving the overall quality of visual effects and storytelling.

An enhanced level of collaboration and communication among teams is also gained from the used of this technology as it allows directors to guide their actors on the motion capture stage as they can see them in their virtual forms composited live into the CG shot, making it possible to adjust on the fly, and allowing for more natural lighting and ambience setups, leading to innovative storytelling and cinematography while offering a more efficient and cost-effective way of making movies and TV shows (Pires et al., 2022, McMahon, 2023) . It also ensures cross-compatibility and digital reuse of assets such as 3D models, which also contributes for significant time and costs savings (Wall, 2023).

Another of the biggest benefits of VP is the ability to transcend actual filming locations. Filmmakers are no longer bound by geographical restrictions, allowing them to create content in diverse and exotic settings that would be prohibitive or financially difficult to use using traditional methods. Additionally, this technology eliminates the need for complex physical assembly, resulting in significant time and cost savings. Lighting control is another area

where VP excels, especially when using led wall technology. Videographers have precise control over lighting settings, from color and brightness to contrast and shadows, which can be adjusted with ease. This level of control speeds up the production process and ensures that every shot is meticulously designed (DeGuzman, 2023).

2.4. Limitations of Virtual Production

As much as VP has revolutionized the film industry, it still holds some limitations that filmmakers must contemplate when considering adopting it. Among these limitations purchasing and maintaining complex equipment, such as led walls, motion capture systems, and a robust IT infrastructure, represent a significant financial investment. Licensing fees, hardware investments, and ongoing maintenance costs can put a strain on production budgets, making VP inaccessible to low-budget projects (Pennington, 2020). In addition, there is demand for personnel with proficiency in VP, especially computer graphics, animation, and virtual reality technology, personnel which there are still few. This talent shortage could lead to increased labor costs as studios compete to find the right professionals for their projects, something that mainly affects smaller production houses and independent filmmaking studios (Kashyap, 2023). In several cases the cost savings this technology brings in the long run is not enough to justify the initial investment the use of VP implies.

VP also brings limitations in terms of creativity. Critics say this could limit filmmakers to predetermined virtual environments, discouraging them from exploring real-world locations, and potentially limit the variety of ways there is to tell stories with images. Additionally, VP projects can limit physical interaction between actors and the virtual environment, posing challenges for specific scenes and performances (Hatch, 2022).

VP's reliance on technology makes it susceptible to technical glitches and errors, which can disrupt production and cause costly delays. The complexity of VP, coupled with the need for specialist skills, can pose significant challenges for small production teams and independent filmmakers therefore they must carefully weigh these limitations against the benefits of VP to strike a balance between creative exploration and authentic on-screen interaction.

2.5. Virtual Production Applications in Healthcare

VP has become a hot topic in the film industry and opens up exciting new opportunities that push the boundaries of imagination in entertainment. These tools are changing the way films are made, and the market for VP tools is expected to grow significantly in the coming years.

Nevertheless, the entertainment industry is not the only one interested on the potential of this technology. Scholars from the health sector have been keeping an eye on these virtual technologies, and studies are beginning to arise in which they study and explore the ways in which these new tools might assist the scientific and health worlds. The small number of relevant scientific documents found shows that there is a need for official and scientific attention to this technology (Pires et al., 2022). This research seek to understand and explore other applications of VP outside of the entertainment industry, and while the little knowledge that exists has a greater focus on virtual reality and augmented reality, it is possible to speculate on how VP can benefit other sectors such as healthcare as the development of digital technologies in medicine, which is one of the prioritized areas worldwide.

The transition of healthcare to a virtual environment is a global social movement aimed at organizing better and more convenient medical care for a person and maintaining a healthy lifestyle. Virtual hospitals, online check-in services, EHR, electronic prescriptions, medical image storage, mobile TV and medication, and online reconciliation of prescriptions are some of the innovations brought by the healthcare virtualization (Virtualization Within Healthcare; Why Is It Important?, 2022).

Virtual medicine is a branch of telemedicine that brings new impetus to the further development of medical informatics through the use of augmented reality and virtual reality technologies. Breakthroughs in digital health are improving doctor-patient interactions (Virtualization Within Healthcare; Why Is It Important?, 2022, Bayona et al., 2011). These technologies have the potential to achieve a wide range of goals, including gamifying medical education, creating virtual surgery simulation to train medical staff, supporting medical rehabilitation, helping patients recover from trauma, patient education, and alleviating phobias (Lawrence, n.d.). Some of the benefits of VP in healthcare include (Virtualization Within Healthcare; Why Is It Important?, 2022):

- The creation of highly realistic 3D models of the human body and organs, as this allows healthcare professionals and patients to better understand complex medical conditions and procedures;
- The feeling of engagement, as the more immersive and interactive a particular environment is, the stronger the sense of realism it evokes;
- The manipulation of multimedia content is particularly effective in the promotion of a sense of telepresence when the multimedia content is indirectly connected to the user's body as it provides an optimal framework for acquiring new user experiences that can be effectively leveraged in the healthcare field;

VP, Virtual Reality and Augmented Reality are transforming many different aspects of healthcare, from medical education and patient engagement to rehabilitation. These technologies provide innovative solutions that not only improve learning and understanding but also support recovery. As they continue to develop, it is possible to expect many more revolutionary applications in healthcare, which ultimately can help to improve the experience and outcomes for both professionals and patients.

3. Methodology

As research around this topic is still limited due to its novelty, as stated before in this article, a speculative approach was used to explore and consider innovative possibilities for health-related VP applications, challenging this relationship by presenting provocative future possibilities that highlight technology and design ramifications, allowing the exploration of both the creative and technological frontiers that VP opens. There was a search for new, unique perspectives through which it would be possible to examine not only the practical context and applications of VP but also shed light on the potential that this technology holds for the coming future. The act of questioning assumptions, accepting ambiguity, and imagining alternative scenarios were central to the case study developed during the SSR&D and presented in this article. By combining creativity, storytelling and informed speculation, this article seeks to stimulate meaningful discussion about the realms of possibility of VP technology applications in healthcare.

4. Case Study

For this project, a video focusing on the topic of health was created following the VP pipeline to understand how it could add to the creation of such content, and what advantages this technology could bring, both from a cinematographic point of view, but also medically, to create awareness for mental health issues. Due to time and man-power limitations associated to this study, it was decided that this study would focus on the conceptual, pre-production phase of the video, accompanied by research and theoretical hypotheses on possible future studies and production steps.

This content mainly consists of informational videos explaining the main characteristics and symptoms of different mental disorders. To this end, a technical script was designed focusing on PTSD.

The script is divided into two narrative moments: a) it's about a fictional character who gets into a car accident and now carries the trauma of the event. The images of the accident appear in her mind as she goes about their daily activities. When thoughts and/or memories arise, her body becomes activated with feelings of nervousness, sweating, increased breathing rate. She may wake up at night with recurring nightmares. regarding what happened. This fear creates the inability to drive. When she gets in the car but start sweating, her heart beats fast, her hands shake, and she gives up; b) a voice-over narration that explains that PTSD appears as a mental disorder caused by exposure to traumatic events or a series of traumatic events which has a significant negative influence on one's mental, physical, social, and spiritual well-being. As mentioned before, this frequently leads to ongoing distress that is marked by vivid dreams, flashbacks, and strong emotions. Research on PTSD was made in order to understand how it affects people that suffer from it and how better it could be represented in a video, in a respectful and empathetic way, while still creating awareness and educating the viewers.

After finalizing the initial version of the video script, the next step was the storyboard development phase. During this phase, the script was refined as necessary to fit the narrative and envisioned scene length. The storyboard went through three separate iterations, each exploring different approaches which also helped to establish scenes to be shot. Fig. 4 showcases the final version of the storyboard.

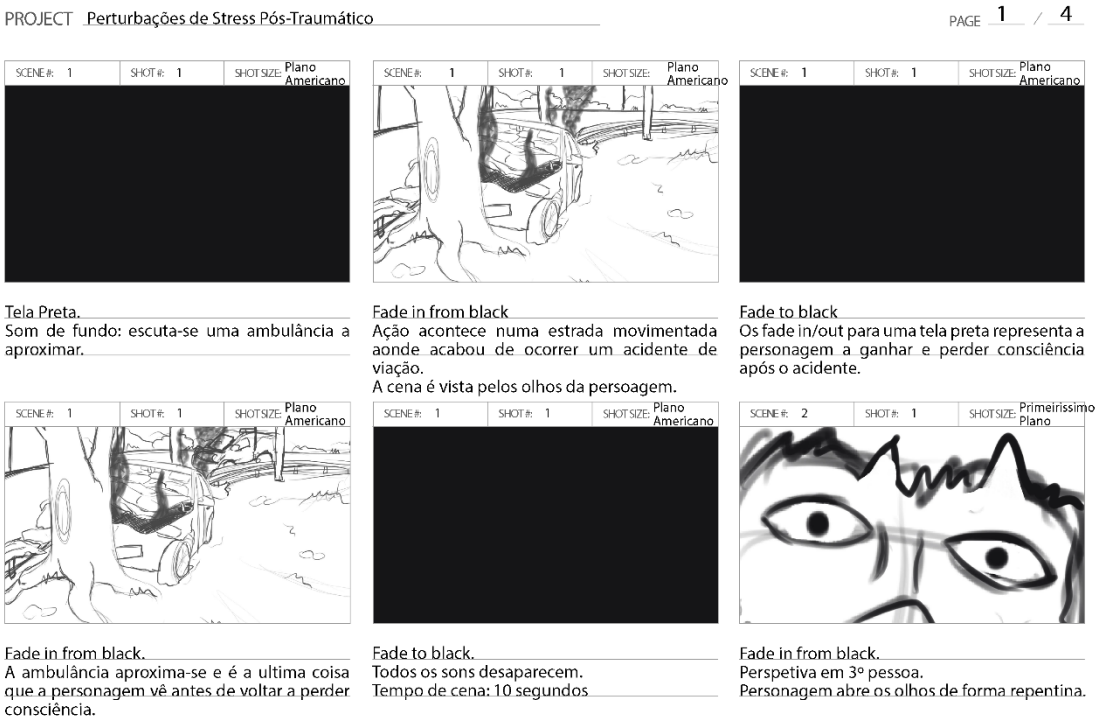

Fig 4. Page 1 of 4 of the storyboard created for the video about PTSD (2023)

From this script, the attention turned to the next stage, creating an animatic using the Procreate digital tool to adjust the animation and framing, and ensuring that each scene met the required timing. The animation was then transferred to Adobe After Effects for further refinement. Once the animation was complete, the Unreal game engine was explored as the main software to create the backgrounds and ambiences for VP. This phase posed some unexpected challenges, as there was no previous experience with the software, and knowledge of 3D modelling was limited. To meet these challenges, extensive self-study and hands-on practice based on tutorials was essential, a long and demanding learning process that paved the way for the successful integration of VP techniques in this project. One of the spaces where the narrative happens was created, as seen in Fig. 5, in this engine, in order to be used as filming background.

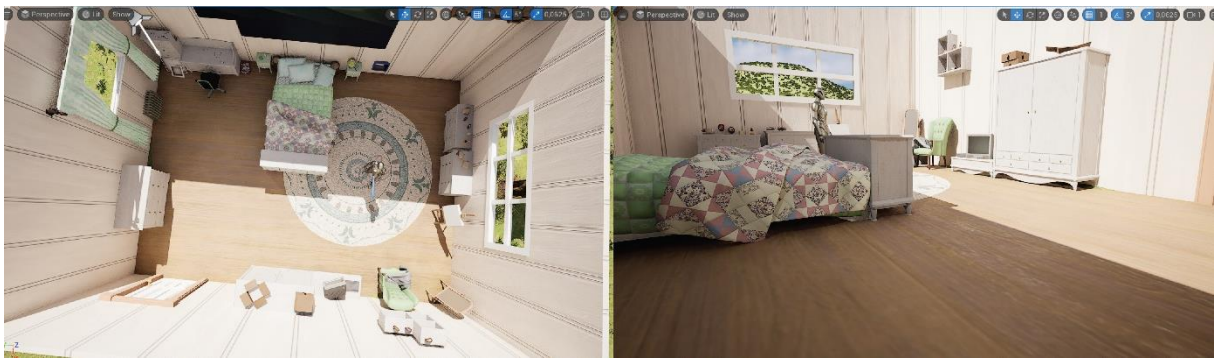

Fig 5. Screenshot of the 3D space created for the PreVis, based on the animatic. The software used was Unreal Engine (2023)

It is from this point that the case study takes on a more speculative aspect, as it was not possible to apply these hypothesis in practice within the project's deadline due to a number of factors, notably the lack of proper hardware and installations such as cameras and synchronization devices to connect real world with virtual cameras, led screens capable of projecting the created 3D environment to allow working with real actors, or even budgets to hire them.

We envision that it would be possible to hire amateur actors or allowing crew members to take the acting roles for the project, but this was not possible within the available time frame. Among the sought alternative solutions was the idea of using a television or a tablet screen to cast the necessary environments and synchronize them with real camera perspectives of actors or using puppets instead of actors. Unfortunately, it was not possible to apply, in practice, the alternatives explored here due to the short and limited period of time that existed to develop this research during the SSR&D grant.

5. Discussion

As VP continues to grow in importance within the film industry, its potential to revolutionize content creation becomes increasingly clear. This technology not only gives filmmakers the ability to create more realistic and detailed images, but also has the potential to democratize filmmaking. Major studios and independent filmmakers will benefit from access to cutting-edge technologies that can level the playing field in the industry. The future of VP is undeniably bright, poised to redefine the cinematic landscape and expand its influence across all levels of the industry (DeGuzman, 2023).

In recent years, virtual reality and augmented reality systems have undergone remarkable development, resulting in increased personalization, portability, real-time orientation, and a more immersive user experience through the integration of visual, tactile, and sensory elements. Additionally, these devices are becoming increasingly popular and accessible to both patients and healthcare professionals. VR and AR technologies have been successfully applied in medical education and rehabilitation training for stroke patients to improve cognitive function, language, and memory. These advances in virtualization technology have the potential to reduce the costs of education and medical rehabilitation, highlighting the growing importance of virtualization technology in the healthcare sector (Virtualization Within Healthcare; Why Is It Important?, 2022).

VP is revolutionizing healthcare content creation by providing benefits such as better visualization, enhanced learning, improved accessibility, cost-effectiveness, and flexibility while filming. As immersive technology advances, we can expect even more innovative applications in VP for medical education and patient care. Adoption of these technologies has the potential to improve healthcare outcomes for everyone (Bayona et al., 2011).

In summary, the case study of video creation using VP for health-related applications provided a unique perspective to examine the potential capabilities of this technology. The case study points that VP can be used for active learning and increased access to medical and patient care training. However, project limitations, such as lack of access to equipment and budget constraints, have highlighted the need for further research and development in this area to overcome the simple basic constrains that are not available to everyone. In general, this case study supported studies already developed about the potential of VP for healthcare and demonstrated its potential to transform healthcare through innovative solutions. However, it is important to continue to discuss and explore more deeply its possibilities, while also addressing the challenges and limitations associated with its implementation. In doing so, it is possible to create better case-sensitive health awareness content which is easier and more efficient to produce.

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